M160™ Internet Router

Hardware Guide

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M160 Internet Router Hardware Guide

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YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. The JUNOS software has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

Table of Contents

About This Manual

Part 1
Product Overview

Chapter 2 Hardware Component Overview

Part 3 Hardware Maintenance and Replacement Procedures

List of Figures

List of Figures

List of Tables

List of Tables

About This Manual

This chapter provides a high-level overview of the *M160 Internet Router Hardware Guide*:

Objectives

This manual explains the hardware installation and basic troubleshooting for the M160 Internet router. It contains procedures for preparing your site for router installation, unpacking and installing the router, starting up the router, performing initial software configuration, and doing routine maintenance and upgrades. After completing the installation and basic configuration procedures covered in this manual, refer to the JUNOS Internet software configuration guides for information about further configuring the JUNOS software.

To obtain additional information about Juniper Networks routers and their PICs—either corrections to information in this manual or information that might have been omitted from this manual—see the hardware release notes.

To obtain the most current version of this manual, the most current version of the hardware release notes, and other Juniper Networks technical documentation, see the product documentation page on the Juniper Networks Web site, which is located at http://www.juniper.net.

To order printed copies of this manual or to order a documentation CD-ROM, which contains this manual, please contact your sales representative.

Audience

This manual is designed for network administrators who are installing and maintaining a Juniper Networks router, or preparing a site for router installation. It assumes that you have a broad understanding of networks in general, the Internet in particular, networking principles, and network configuration. Any detailed discussion of these concepts is beyond the scope of this manual.

Document Organization

This manual is divided into several parts, each containing a category of information about the router:

- “Product Overview” on page 1 provides an overview of the router, describing its hardware components, the JUNOS software, and the system architecture.
- “Initial Installation” on page 51 describes how to prepare your site for installing the router, providing environmental and power specifications, rack and clearance requirements, wiring and cabling guidelines, and safety warnings and guidelines. It also describes how to unpack and install the router, how to power up the router, and how to initially configure the software.
- “Hardware Maintenance and Replacement Procedures” on page 157 provides general maintenance information for the router, and describes how to maintain and replace router components.
- “Troubleshooting” on page 229 provides basic troubleshooting information for router components, and explains how to track problems in hardware components to their source. It also tells you how to contact the Juniper Technical Assitance Center (JTAC).
- “Appendixes” on page 243 provides information on cables and connectors, cleaning fiber-optic connections, and returning the router or router components. It also provides a glossary of terms.
- “Index” on page 271 provides an index to the guide.

Related Documents

For more information about Physical Interface Cards (PICs) for the M160 router, see the *M160 Internet Router PIC Guide*.

For information about configuring the software, including examples, see the following documents:

- JUNOS Internet software configuration guides
- *JUNOS Internet Software Operational Mode Command Reference*
- *JUNOScript API Guide* and *JUNOScript API Reference*

Documentation Conventions

This manual uses the following text conventions:

- Router and router component labels are shown in a sans serif font. In the following example, ETHERNET is the label for the Ethernet management port on the router:

  The 10/100-Mbps Ethernet RJ-45 connector is used for out-of-band management of the router and is labeled ETHERNET.

- Statements, commands, filenames, directory names, IP addresses, and configuration hierarchy levels are shown in a sans serif font. In the following example, stub is a statement name and [edit protocols ospf area *area-id*] is a configuration hierarchy level:

  To configure a stub area, include the stub statement at the [edit protocols ospf area *area-id*] hierarchy level.

- In examples, text that you type literally is shown in bold. In the following example, you type the words **show chassis alarms**:

  For example, you can use the following command to get information about the source of an alarm condition:

  user@host> **show chassis alarms**

Notes, Cautions, and Warnings

Notes, cautions, and warnings are denoted by the following symbols:

Note

A note indicates information that might be helpful in a particular situation or that might otherwise be overlooked.

Caution

A caution indicates a situation that requires careful attention. Failure to observe a caution could result in minor injury or discomfort to yourself, or serious damage to the router.

Warning

A warning indicates a potentially dangerous situation. Failure to follow the guidelines in a warning could result in severe injury or death.

Contact Juniper Networks

For technical support, contact Juniper Networks at support@juniper.net, or at 1-888-314-JTAC (within the United States) or 408-745-2121 (from outside the United States).

Documentation Feedback

We are always interested in hearing from our customers. Please let us know what you like and do not like about the product documentation, and let us know of any suggestions you have for improving the documentation. Also, let us know if you find any mistakes in the documentation. Send your feedback and comments to tech-doc@juniper.net.

Part 1
Product Overview

Chapter 1
System Overview

This chapter provides an overview of the M160 Internet router, discussing the following topics:

System Description

The M160 Internet router is a complete routing system that provides SONET/SDH, ATM, Gigabit Ethernet, and other high-speed interfaces for large networks and network applications, such as those supported by Internet service providers (ISPs).

Application-specific integrated circuits (ASICs), a definitive part of the router system design, enable the router to achieve data forwarding rates that match current fiber-optic capacity.

The router accommodates up to eight Flexible PIC Concentrators (FPCs), which can each be configured with a variety of network media types—altogether providing up to 32 OC-12, 32 OC-48, or 8 OC-192 ports per system.

The router's maximum aggregate throughput is 160 Gbps. The router can forward traffic at line rate for any combination of PICs that does not exceed 3 Gbps on a single FPC1 or 10 Gbps on a single FPC2. Any combination exceeding 3 Gbps on a FPC1 or 10 Gbps on an FPC2 is supported, but constitutes oversubscription.

The router architecture cleanly separates control operations from packet forwarding operations. This design eliminates processing and traffic bottlenecks, permitting the router to achieve a high rater of performance. Control operations in the router are performed by the Routing Engine, which runs JUNOS Internet software to handle routing protocols, traffic engineering, policy, policing, monitoring, and configuration management. Forwarding operations in the router are performed by the Packet Forwarding Engine, which consists of hardware, including ASICs, designed by Juniper Networks.

The router is a modular, rack-mountable system. Its size allows two routers to be installed in one standard, 78-in.-high Telco rack.

Field-Replaceable Units (FRUs)

Field-replaceable units (FRUs) are router components that can be replaced at the customer site. Replacing FRUs requires minimal router downtime. There are three types of FRUs:

- Hot-insertable and hot-removable FRUs—You can remove and replace these components without powering down the router or disrupting the routing functions.
- Hot-pluggable FRUs—You can remove and replace these components without powering down the router, but the routing functions of the system are interrupted when the component is removed.
- FRUs that require powering down—You must power down the router before removing these components.

Table 1 lists the FRUs for the router:

Table 1: Field-Replaceable Units

Hot-removable and hot-insertable FRUs	Hot-pluggable FRUs	FRUs requiring powerdown
■ Switching and Forwarding Modules (SFMs) ■ Flexible PIC Concentrators (FPCs) ■ Physical Interface Cards (PICs) ■ Power supplies ■ Front and rear impeller assemblies ■ Fan tray with cable management system ■ Air filter	■ PFE Clock Generators (PCGs) ■ Routing Engine ■ Miscellaneous Control Subsystem (MCS)	■ Connector Interface Panel (CIP) ■ Circuit breaker box

For FRU replacement instructions, see “Hardware Maintenance and Replacement Procedures” on page 157.

Component Redundancy

The router is designed so that no single point of failure can cause the entire system to fail. The following major hardware modules are redundant:

- SFMs—The router can have up to four interconnected SFMs. If one SFM fails, the switching and forwarding functions of the failed module are distributed among the remaining SFMs. Total bandwidth is reduced by $1/n$, where n is the total number of SFMs installed in the router. For example, in a system with four SFMs, each SFM handles 25 percent of the forwarding capacity.
- PCGs—The router has two PCGs. Both PCGs send their clock signals to the forwarding components, along with a signal that indicates which clock is the master. If one PCG fails, the other PCG becomes the master system clock.

- Host module—Comprises a Routing Engine and MCS functioning together. The router can have one or two host modules. If two host modules are installed, one functions as the master and the other as backup. If the master host module (or either of its components) fails, the backup takes over as the master host module. To operate, each host module requires a Routing Engine and MCS to be installed in adjacent slots.

- Power supplies—The router has two power supplies, which share the load evenly. If one of the power supplies fails, the second power supply can supply full power to the router's components indefinitely.

- Cooling system—The front and rear cooling subsystems have redundant components, which are controlled by the MCS. If an impeller or fan fails, the MCS increases the speed of the remaining impellers and fans to provide sufficient cooling for the unit indefinitely.

Note

Standard configurations of the router include a single host module (Routing Engine and MCS), and multiple SFMs, PCGs, and power supplies. This manual refers to the Routing Engine and MCS in the singular, but refers to multiple SFMs, PCGs, and power supplies.

Safety Requirements, Warnings, and Guidelines

Installing and maintaining the router involves working with electrical components. While it is assumed that you have a working knowledge of safety requirements necessary in working with Internet routers, you also need to know the procedures for working safely with and near electrical equipment. A more detailed description of the hazards associated with working with the router is provided in "Prepare the Site" on page 53. However, providing specific guidelines for working with electrical equipment is beyond the scope of this manual.

For a listing of safety warnings for the router, see "Regulatory Compliance and Safety Information" on page 73.

System Specifications

Table 2 lists the router's physical and environmental specifications.

Table 2: Physical and Environmental Specifications

Description	Value
Physical Specifications	
Chassis height	35 in. (88.9 cm)
Chassis width	17.5 in. (44.5 cm) sides of chassis 19 in. (48.3 cm) rack-mounting ears
Chassis depth	29 in. (73.6 cm)
Weight, maximum configuration	370.5 lbs (168 kg)
Weight, minimum configuration	190 lbs (86 kg)
Environmental Specifications	
Altitude	No performance degradation to 10,000 ft (3048 m)
Relative humidity	Normal operation ensured in relative humidity range of 5% to 90%, noncondensing
Temperature	Normal operation ensured in temperature range of 32°F to 104°F (0°C to 40°C)
Shock	Tested to meet Bellcore Zone 4 earthquake requirements
Thermal output	9400 BTU/hour

Chapter 2
Hardware Component Overview

This chapter provides an overview of the M160 Internet Router hardware components:

Chassis

The router chassis is a rigid sheet metal structure that houses all the router hardware components (see Figure 1, Figure 2, and Figure 3). The chassis is 35 in. (89 cm) high, 17.5 in. (44.4 cm) wide, and 29 in. (73 cm) deep. It is 19 in. (48.3 cm) wide to the tips of the rack-mounting ears. The chassis installs into standard 19 in. equipment racks or Telco center-mounted racks, and two routers can be installed into one standard, 78-in. rack.

The chassis includes the following features:

- Two front support posts used to bolt the chassis to a front-mounting rack
- Two 19” rack-mounting ears for center rack mounting
- Two electrostatic discharge (ESD) points (banana plug receptacles), one front and one rear
- Two internally threaded inserts providing grounding points for the router.

Before removing or installing any components of a functioning router, attach an ESD strap to one of the two ESD points on the chassis (see Figure 1 and Figure 2) and attach the other end of the ESD strap around your bare wrist. Failure to use an ESD strap could result in damage to the router and its components.

Figure 1: Front View of Chassis

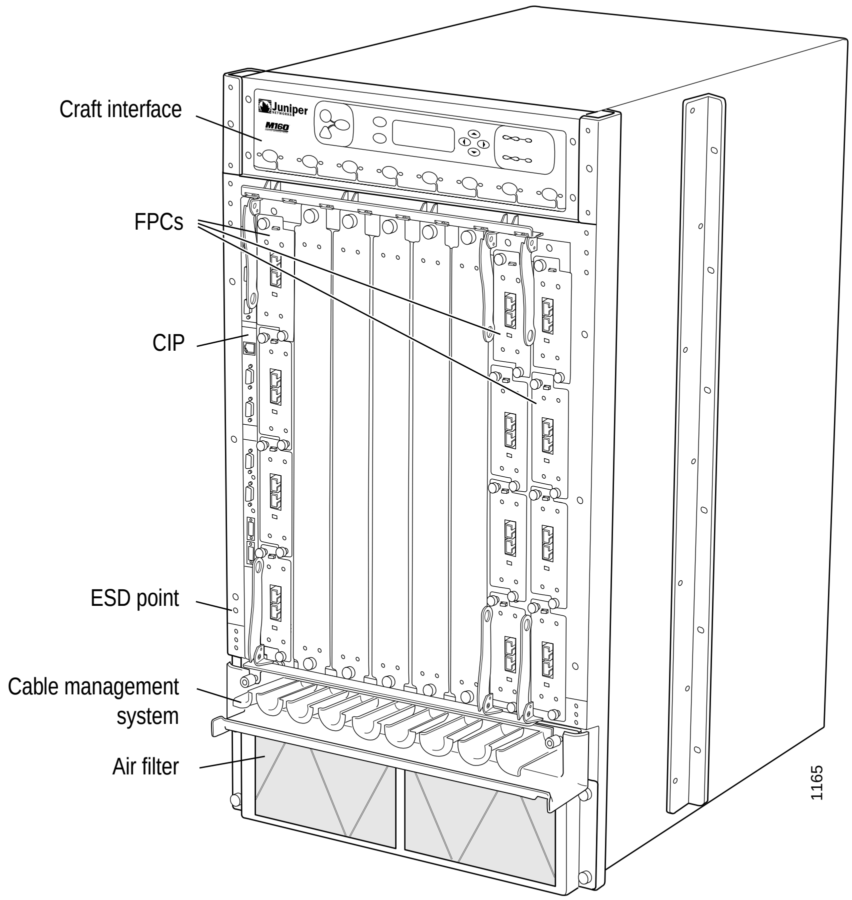


Figure 2: Rear View of Chassis

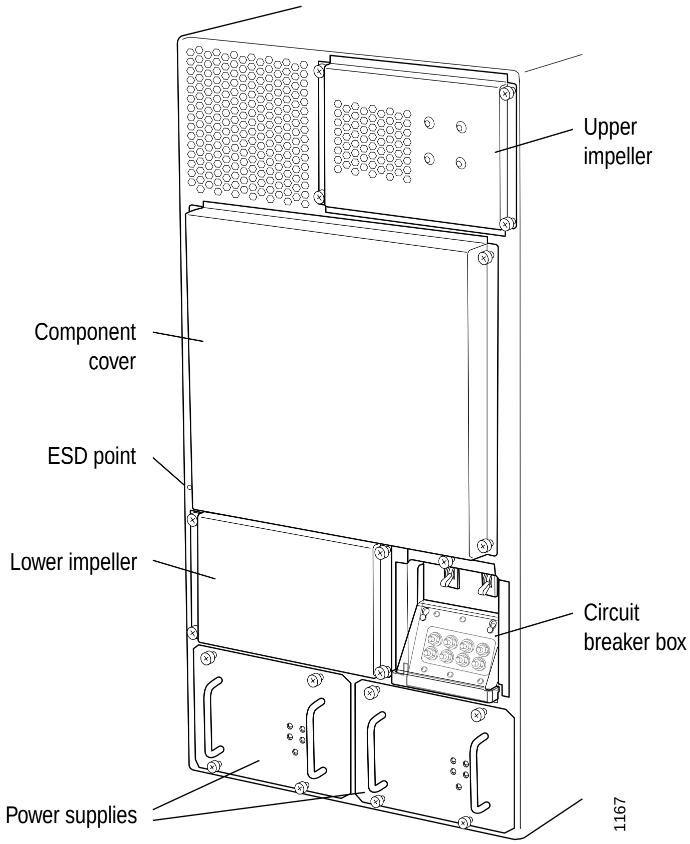
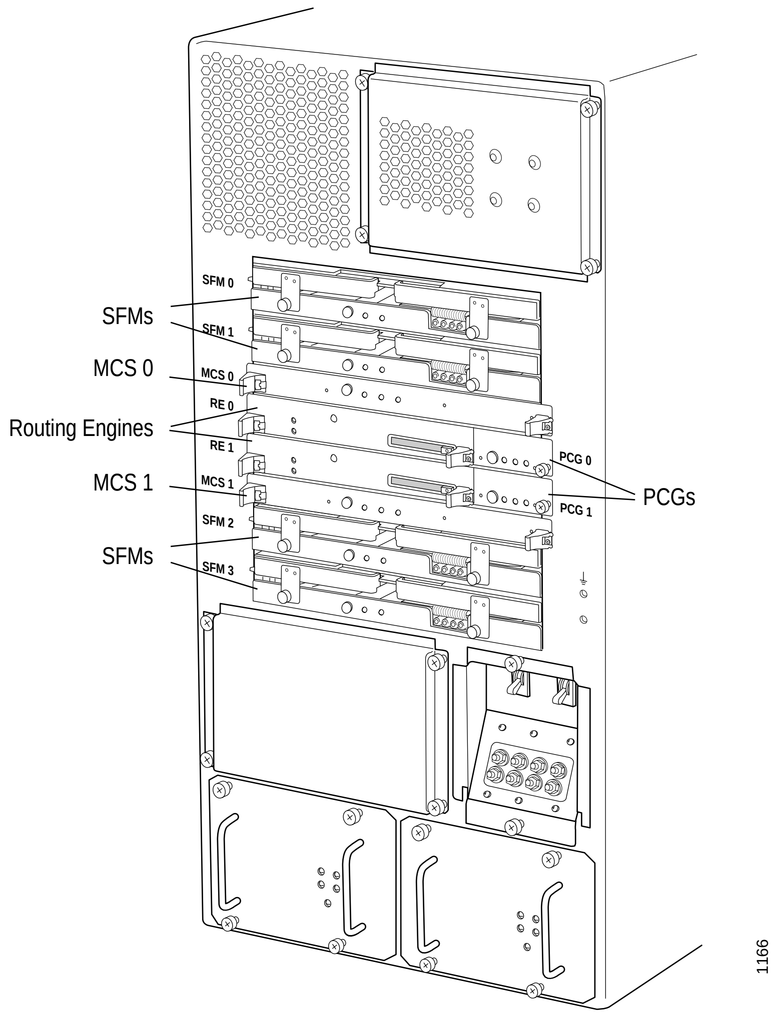


Figure 3: Rear View of Chassis with Component Cover Removed



Packet Forwarding Engine

The Packet Forwarding Engine (PFE) provides Layer 2 and Layer 3 packet switching, route lookups, and packet forwarding. The Packet Forwarding Engine uses application-specific integrated circuits (ASICs) to perform these functions. ASICs include the Distributed Buffer Manager, I/O Manager, Internet Processor II, Packet Director, and various media-specific controllers.

The Packet Forwarding Engine consists of the following components:

- Midplane—A single, passive midplane is located in the center of the chassis. The FPCs install vertically into the midplane from the front of the chassis, and the SFMs, Routing Engine, MCS, and PCGs install horizontally from the rear of the chassis.

- Switching and Forwarding Modules (SFMs)—From one to four SFMs can be installed into the rear of the chassis.

- Flexible PIC Concentrators (FPCs)—From one to eight FPCs can be installed into the front of the chassis. Each FPC has a set of connectors for attaching one or more PICs.
- Physical Interface Cards (PICs)—From one to four PICs can be installed in each FPC. PICs provide support for various network media, including OC-12 ATM, OC-12, OC-48 and OC-192 SONET/SDH, Channelized OC-12, and Gigabit Ethernet.
- PFE Clock Generators (PCGs)—Two PCGs are installed into the rear of the chassis.

Midplane

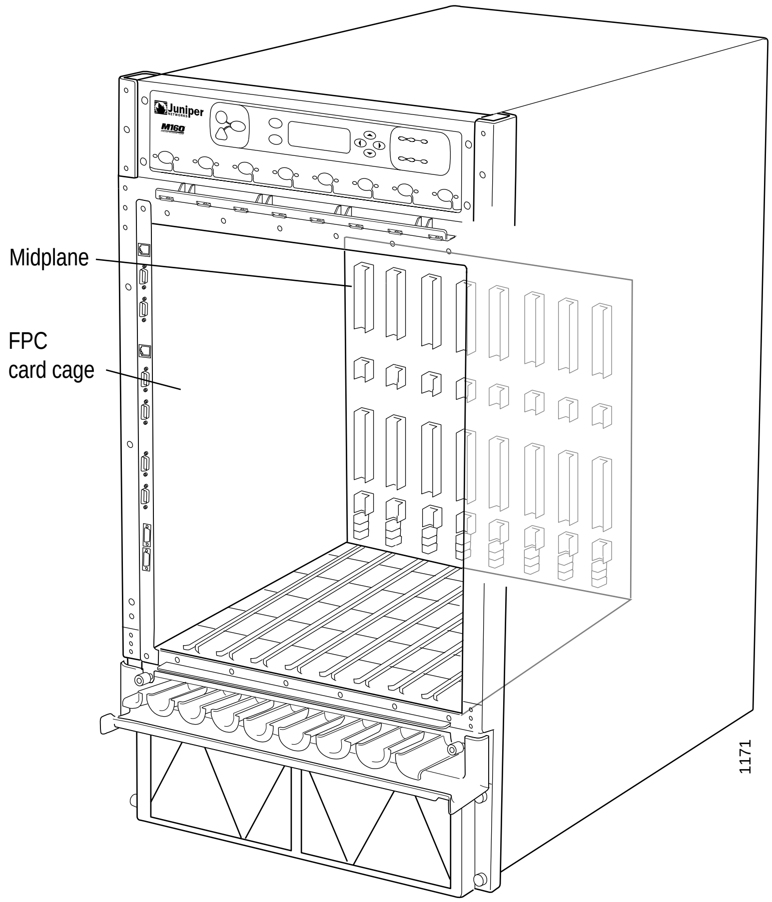
The midplane is located in the center of the chassis and forms the rear of the FPC card cage (see Figure 4). The FPCs install into the midplane from the front of the chassis, and the SFMs, Routing Engines, MCSs, and PCGs install into the midplane from the rear of the chassis. The power supplies and cooling system components also connect to the midplane.

The midplane contains an EEPROM that stores the serial number and revision level of the midplane.

The midplane performs the following major functions:

- Transfer of data—Data packets are transferred across the midplane from the FPCs to the SFMs, which perform their switching and forwarding function, then transfer the packets back across the midplane to the shared memory buffers on the FPCs.
- Power distribution—The router power supplies are connected to the midplane, which distributes power to all the router’s components.
- Signal connectivity—The midplane provides signal connectivity to the FPCs, SFMs, Routing Engines, and other system components for monitoring and control of the system.

Figure 4: Midplane



Switching and Forwarding Modules (SFMs)

The Switching and Forwarding Modules (SFMs) provide route lookup, filtering, and switching to the destination FPC. Up to four interconnected SFMs can be installed in the router, providing a total of 160 million packets per second (Mpps) of forwarding. The SFMs provide the following functions:

- Route lookups—The Internet Processor II ASIC on each SFM performs route lookups using the forwarding table stored in the synchronous SRAM (SSRAM).

- Management of shared memory on the FPCs—One Distributed Buffer Manager ASIC on each SFM uniformly allocates incoming data packets throughout shared memory on the FPCs.

- Transfer of outgoing data packets to the FPCs—A second Distributed Buffer Manager ASIC on each SFM passes data packets to the FPCs for reassembly when the data is ready to be transmitted.

- Transfer of exception and control packets—The Internet Processor II ASIC passes exception packets to the microprocessor on the SFM, which processes almost all of them. The remainder are sent to the Routing Engine for further processing. Any errors originating in the Packet Forwarding Engine and detected by the SFMs are sent to the Routing Engine using syslog messages.

The SFMs are hot-removable and hot-insertable. Inserting or removing an SFM causes a brief interruption in forwarding performance (about 500 ms) as the Packet Forwarding Engine reconfigures the distribution of packets across the remaining SFMs.

SFM Components

The SFM (see Figure 5) is a two-board system comprising the following components:

- Two Distributed Buffer Manager ASICs—One sends packets to the output buffer and one forwards notification to the I/O Manager ASICs on the FPCs.

- Internet Processor II ASIC—Performs route lookups.

- 8-MB of parity-protected SSRAM.

- Processor subsystem—Comprises one PowerPC603e processor, 256-KB of parity-protected Level 2 cache, and 64-MB of parity-protected DRAM. This subsystem handles exception packets and management of the SFM.

- EEPROM—Stores the serial number and revision level.

- Two LEDs—One green OK and one amber FAIL, located on the SFM faceplate. Table 3 describes the functions of the SFM LEDs.

- Offline button for module removal.

Figure 5: SFM

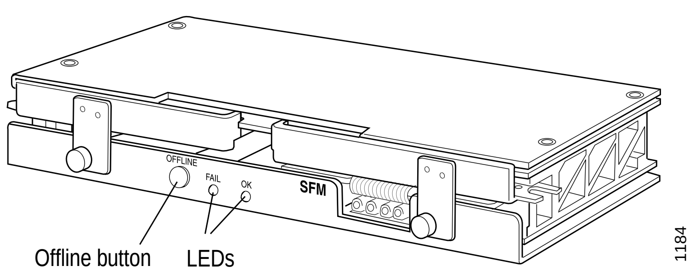


Table 3: SFM LEDs

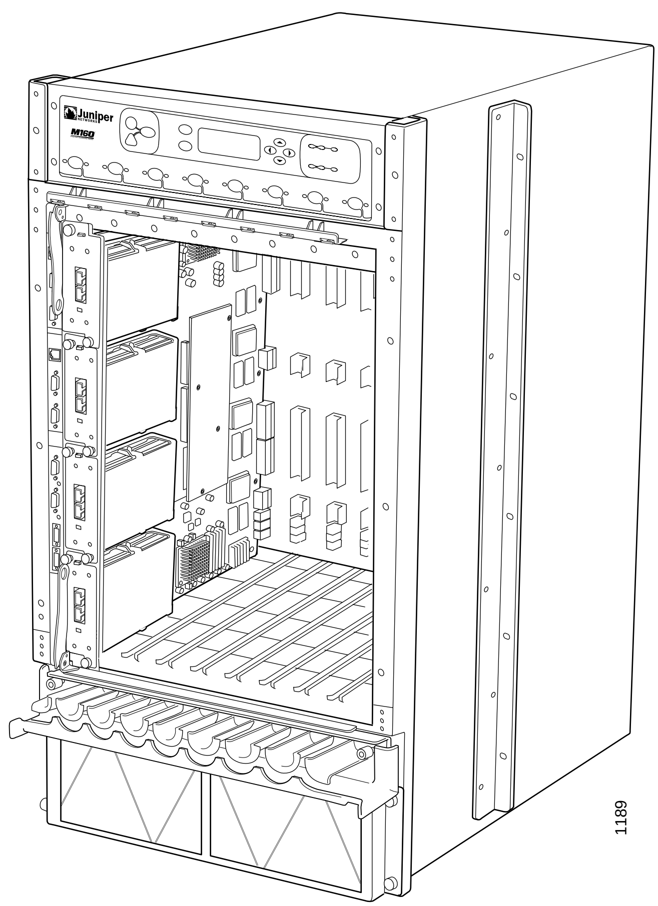
Label	Color	State	Description
OK	Green	On steadily	SFM is functioning normally.
		Blinking	SFM is starting up.
FAIL	Amber	On steadily	SFM has failed.

Flexible PIC Concentrators (FPCs)

The Flexible PIC Concentrators (FPCs) house the various PICs used in the router. Up to eight FPCs install vertically into the midplane from the front of the chassis (see Figure). The FPCs are numbered left to right, from FPC0 to FPC7. Each FPC has four connectors into which a PIC can be installed, allowing up to four PICs per FPC. An FPC can be installed into any FPC slot, regardless of the PICs it contains.

If a slot is not occupied by an FPC, a blank FPC panel must be installed to shield the empty slot and to allow cooling air to circulate properly through the FPC card cage.

Figure 6: FPC with PICs in the Chassis



The FPCs connect the PICs to the rest of the router so that incoming packets can be forwarded across the midplane to the appropriate destination port. FPCs contain shared memory, which is managed by the Distributed Buffer Manager ASIC on each SFM, for storing data packets received by the PICs. The I/O Manager ASIC on each FPC divides incoming data packets from the PICs into 64-byte memory blocks, which are stored in a shared memory buffer, and reassembles them into data packets when they are ready for transmission.

FPCs are hot-insertable and hot-removable. Removing an FPC causes a brief interruption of forwarding performance (about 200 ms) as the Packet Forwarding Engine flushes the memory pool.

When you install an FPC into an operating router and its offline button is pressed, the Routing Engine downloads the FPC software, the FPC runs its diagnostics, and the PICs on the FPC slot are enabled. No interruption occurs to the routing functions.

FPC Components

Each FPC contains the following components:

- FPC card carrier—Contains the ASICs, connectors, and processor subsystem.
- Four I/O Manager ASICs—Parse Layer 2 and 3 data and perform encapsulation and segmentation. Enhanced FPCs have I/O Manager ASICs capable of enhanced quality of service.
- Two Packet Director ASICs—One distributes incoming packets to the I/O Manager ASICs and the second directs outgoing packets from the I/O Manager ASIC to the PICs.
- Eight identical 32-MB SDRAM DIMMs—Form the shared memory buffer for the system.
- Parity-protected SSRAM—Stores data structures used by the I/O Manager ASICs. Standard FPCs have 1 MB of SSRAM, enhanced FPCs have 2 MB of SSRAM.
- Processor subsystem—Comprises one PowerPC 603e-based CPU with 32 MB of parity-protected DRAM.
- EEPROM—Stores the serial number and revision level of the FPC.
- Two LEDs—One green OK and one red FAIL, located on the craft interface. Table 8 describes the functions of the FPC LEDs.
- Offline button—Located on the craft interface and used for module removal and installation. Table 8 on page 26 provides more information about the FPC offline buttons.

FPC1 and FPC2

The router supports two types of FPC:

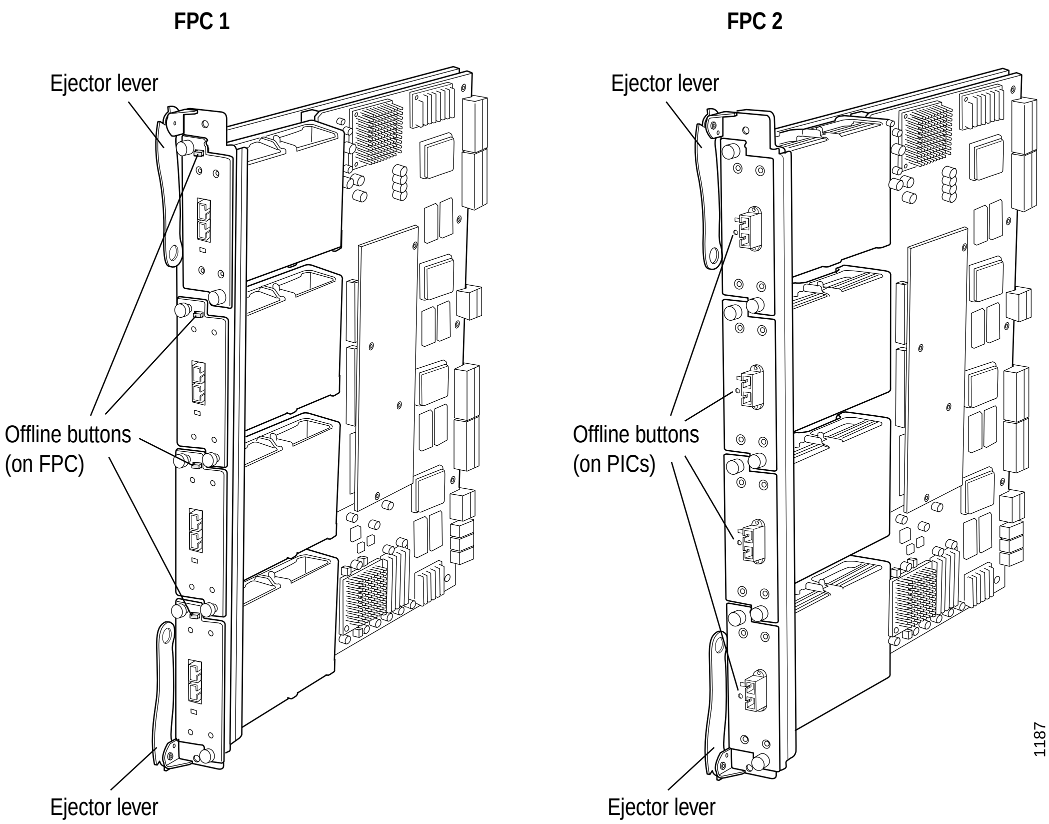
- FPC1—Standard or enhanced. Supports PICs including single-port OC-12 and Gigabit Ethernet.
- FPC2—Standard or enhanced. Supports higher-speed PICs including OC-48 and Tunnel services.

The router can operate with any combination of FPC1s and FPC2s installed.

Enhanced FPCs have I/O Manager ASICs capable of enhanced quality of service, and 2 MB of SSRAM. Enhanced FPCs can be identified through the CLI, or by a sticker on the faceplate.

The installation and removal of the two FPC types is identical. PICs that can be inserted on an FPC2 are distinguished by having an offline button on their faceplate. The FPC1 has built-in offline buttons for the PICs it holds (see Figure 7). In this manual, both the FPC1 and FPC2 are referred to simply as “FPC” except where the differences between the two are being discussed.

Figure 7: FPC1 and FPC2



Physical Interface Cards (PICs)

You can install up to four Physical Interface Cards (PICs) into slots on each FPC (see Figure 6 on page 15). PICs provide the physical connection to various network media types.

PICs receive incoming packets from the network and transmit outgoing packets to the network. During this process, each PIC performs framing and line-speed signaling for its media type. Before transmitting outgoing data packets, the PICs encapsulate the packets received from the FPCs. Each PIC is equipped with an ASIC that performs control functions specific to the PIC’s media type.

PICs are hot-removable and hot-insertable. Before removing a PIC or after installing a PIC, press the offline button.

PIC Offline Buttons

Each PIC has an offline button used for hot-removing and hot-inserting the PIC in an operating router. The PICs that insert into an FPC2 each have an offline button on their faceplates. For the PICs that insert into an FPC1, the offline button is on the FPC1 card carrier.

PIC Media Types

The router supports various PICs, including ATM, Channelized OC-12, Gigabit Ethernet, SONET/SDH, and Tunnel services PICs. The number of ports on each PIC and the number of PICs that can be installed in a single FPC depend on the network media type (PIC interface) and the FPC type.

For more information about the PICs, including cable and connector information and information about specific media types, see the *M160 Internet Router PIC Guide*.

PFE Clock Generators (PCGs)

The router has two PFE Clock Generators (PCGs), located in the rear of the chassis to the right of the Routing Engine slots. The PCGs supply the 125-MHz system clock to the components of the Packet Forwarding Engine (see Figure 8). During startup, the active Routing Engine determines which PCG is master and which is backup, and the MCS relays the decision to the PCGs and to the modules and ASICs in the Packet Forwarding Engine that use the clock signal. The modules and ASICs then use only the signal from the master source.

The PCGs both send clock signals to the Packet Forwarding Engine modules, along with a signal indicating which is the master clock source. The master Routing Engine controls which PCG is master and which is backup.

The PCGs are hot-pluggable.

PCG Components

Each PCG contains the following components:

- 125-MHz system clock generator
- EEPROM—Stores the serial number and revision level of the PCG
- Three LEDs—one blue MASTER, one green OK and one amber FAIL. located on the PCG faceplate. Table 4 describes the functions of the PCG LEDs.
- Offline button for module removal

Figure 8: PFE Clock Generator

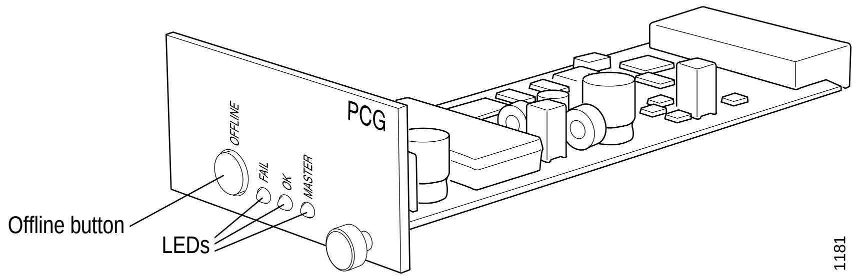


Table 4: PCG LEDs

Color	Label	State	Description
Blue	MASTER	On steadily	PCG is master
Green	OK	On steadily	PCG is operating normally
		Blinking	PCG is starting up
Amber	FAIL	On steadily	PCG has failed

Host Module

The host module provides the routing and system management functions of the router. Additionally, the host module provides the clock source for SONET/SDH interfaces.

The host module consists of the following components:

- Routing Engine
- Miscellaneous Control Subsystem (MCS)

The router can be equipped with one or two host modules. For each host module, the Routing Engine and MCS function as a unit, each component requiring the other to operate; if the adjacent component is not present, a Routing Engine or MCS will not operate, even if physically installed in the router.

Routing Engine

The Routing Engine (see Figure 9) consists of an Intel-based PCI platform running JUNOS Internet software. The Routing Engine maintains the routing tables used by the router and controls the routing protocols that run on the router. For a more detailed description of the Routing Engine, see “Routing Engine” on page 47.

The Routing Engine installs into the center rear of the chassis (see Figure on page 11). The Routing Engine is hot-pluggable.

The router can be equipped with up to two Routing Engines for redundancy. If two Routing Engines are installed, one acts as the master Routing Engine and the other acts as backup. If the master Routing Engine fails or is removed, the backup restarts and becomes the master Routing Engine.

Each Routing Engine requires an MCS to be installed in an adjacent slot. RE0 installs below MCS0, and RE1 installs above MCS1. Even if a Routing Engine is physically installed in the chassis, it does not function if no MCS is present in the adjacent slot.

Routing Engine Components

Each Routing Engine is a two-board system with the following components:

- CPU—Runs JUNOS Internet software to maintain the router's routing tables and routing protocols. It has a Pentium-class processor.
- SDRAM—Provides storage for the routing and forwarding tables and for other Routing Engine processes.
- Compact flash disk—Provides primary storage. It can accommodate two software images, two configuration files, and microcode. This disk is fixed and inaccessible from outside the router.
- Hard disk—Provides secondary storage for log files, memory dumps, and rebooting the system if the flash disk fails.
- PC card slot—Accepts a removable PC card, which stores software images for system upgrades.
- Interfaces for out-of-band management access—Provide information about Routing Engine status to devices (console, laptop, or terminal server) that can be attached to the Routing Engine ports located on the CIP. For more information, see "Routing Engine Ports" on page 28.
- EEPROM—Stores the serial number of the Routing Engine.
- LED—Indicates disk activity for the internal IDE interface. It does not necessarily indicate routing-related activity.

  The LEDs that report Routing Engine status are located on the craft interface. For more information, see "Craft Interface" on page 23.
- Reset button—Reboots the Routing Engine when pressed.
- Extractor clips—Control the locking system that secures the Routing Engine in the chassis.

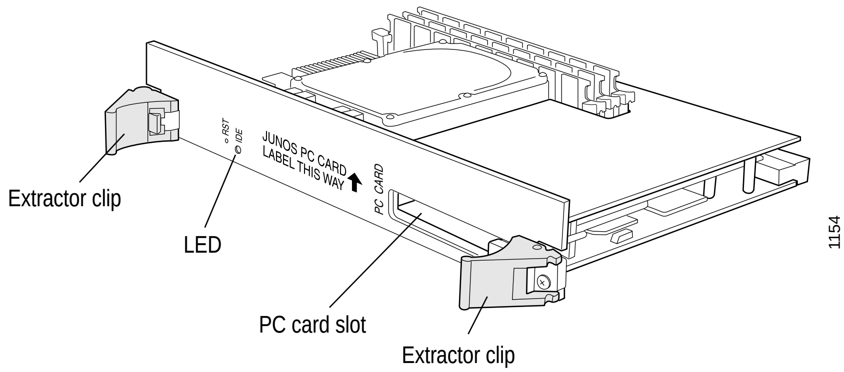
Note

The appearance and position of electronic components or the PC card slot on your Routing Engine might differ from Figure 9 and other figures in this document. These differences do not affect Routing Engine functionality.

Note

For specific information about components in your Routing Engine (for example, the capacity of the hard disk), issue the `show chassis routing-engine` command.

Figure 9: Routing Engine



Miscellaneous Control Subsystem (MCS)

The MCS (see Figure 10) works with the Routing Engine to provide control and monitoring functions for router components and to provide SONET clocking for the router. The MCS installs into the midplane from the rear of the chassis (as shown in Figure on page 11).

The router can be equipped with up to two MCSs for redundancy. If two MCSs are installed, one acts as the master MCS and the other acts as backup. If the master MCS fails or is removed, the backup restarts and becomes the master MCS.

Each MCS requires a Routing Engine to be installed in an adjacent slot. MCS0 installs above RE0, and MCS1 installs below RE1. Even if an MCS is physically installed in the chassis, it does not function if no Routing Engine is present in the adjacent slot.

The MCS performs the following functions:

- Monitoring and control of router components—Monitors components for failure and alarm conditions. The MCS collects statistics from all sensors in the system and relays them to the Routing Engine, which generates control messages or sets an alarm. The MCS relays control messages from the Routing Engine to the router components.

- Power-up and power-down of components—Controls the power-up sequence of router components at startup, and powers down components when their offline buttons are pressed.

- Control of mastership—In a system with redundant Routing Engine, MCS, or PCG modules, the MCS signals which of the modules is the master and which is the backup.

- Control of FPC resets—If the MCS detects errors in an FPC, it attempts to reset the FPC. After three unsuccessful resets, the MCS takes the FPC offline and informs the Routing Engine. Other FPCs are unaffected, and normal system operation continues.

- SONET clock source—The MCS generates the 19.44-MHz SONET clock. Each MCS supplies the SONET clock signal, along with a signal that indicates which MCS is the master SONET clock. Each MCS also provides two BITS interfaces for synchronization of the SONET clocks to an external reference source.

  The MCS also monitors the SONET clock, the SONET reference clocks (from the FPCs and the BITS interfaces), and the system clocks from the PCGs.

MCS Components

The MCS contains the following components:

- PCI interface to the Routing Engine
- 100-Mbps Ethernet switch for inter-module communication
- 19.44-MHz stratum 3 reference clock for SONET/SDH PICs
- Two BITS interfaces for external clock reference
- I^2C controller to monitor the status of router components
- Three LEDs—One blue MASTER, one green OK, and one amber FAIL, located on the MCS faceplate. Table 5 describes the functions of the MCS LEDs.
- Offline button for module removal

Figure 10: MCS

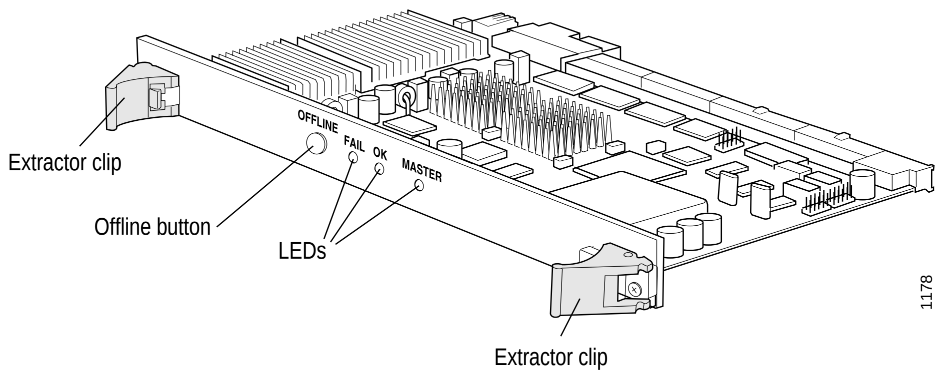


Table 5: MCS LEDs

Label	Color	State	Description
MASTER	Blue	On steadily	MCS is master.
OK	Green	On steadily	MCS is operating normally.
		Blinking	MCS is starting up.
FAIL	Amber	On steadily	MCS has failed.

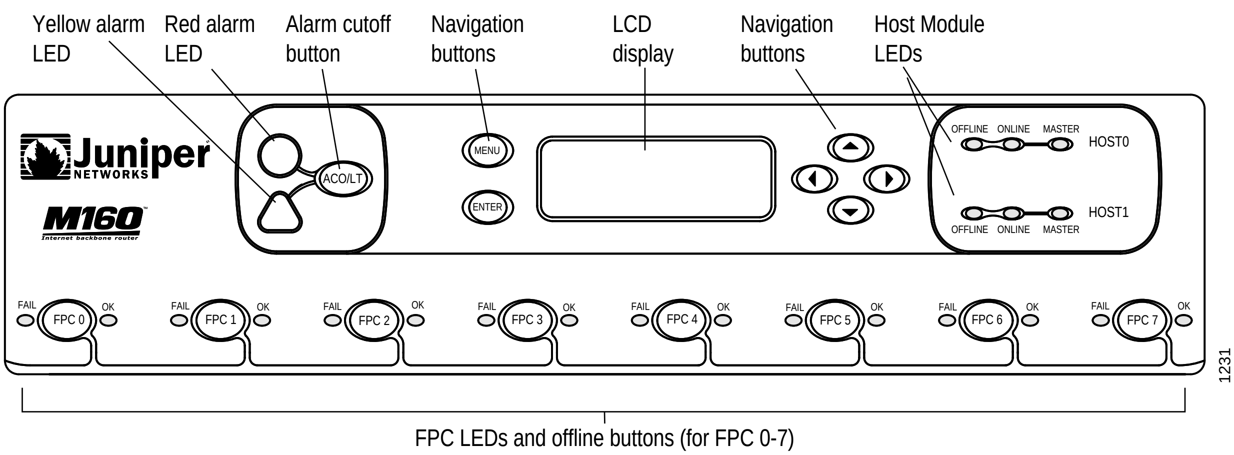
Craft Interface

The craft interface allows you to view status and troubleshooting information at a glance and to perform many system control functions. The craft interface is located on the front of the chassis above the FPC card cage and contains the following elements (see Figure 11):

- Alarm LEDs and Alarm Cutoff Button on page 23
- LCD Display and Navigation Buttons on page 24
- Host Module LEDs on page 26
- FPC LEDs and Offline Button on page 26

> **Note**
> The LEDs for the SFMs, MCS, PCGs and power supplies are located on their respective faceplates, not on the craft interface. These LEDs are described in the section for each component.

Figure 11: Front Panel of the Craft Interface



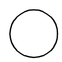
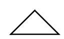
Alarm LEDs and Alarm Cutoff Button

Two large alarm LEDs are located at the upper left of the craft interface (see Figure 11). The circular red LED lights to indicate a critical condition that can result in a system shutdown. The triangular yellow LED lights to indicate a less severe condition that requires monitoring or maintenance. Both LEDs can be lit simultaneously. Table 6 describes the alarm LEDs in more detail.

A condition that causes an LED to light also activates the corresponding alarm relay contact on the CIP, as described in “Alarm Relay Contacts” on page 29. The LCD display on the craft interface reports the cause of the alarm, as described in “Alarm Mode” on page 25.

To deactivate red and yellow alarms, press the button labeled ACO/LT (for “alarm cutoff/lamp test”), which is located to the right of the alarm LEDs. Deactivating an alarm turns off both LEDs and deactivates the device attached to the corresponding alarm relay contact on the CIP. However, the LCD display continues to report the alarm message until you clear the condition that caused the alarm.

Table 6: Alarm LEDs and Alarm Cutoff Button

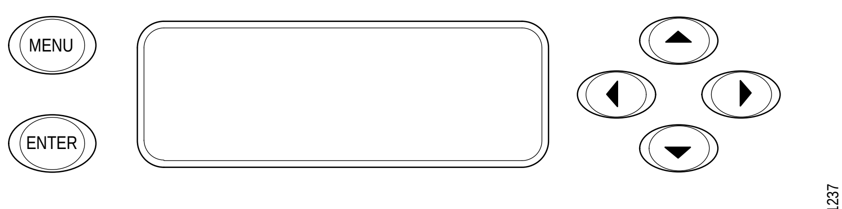
Object	Shape	Color	State	Description
RED ALARM LED		Red	On steadily	System failure or power supply failure; system shut down because of hardware malfunction or some threshold being exceeded
YELLOW ALARM LED		Amber	On steadily	System warning such as maintenance alert or significant temperature increase
ACO/LT		—	—	Alarm cutoff: Deactivates red and yellow alarms.

LCD Display and Navigation Buttons

The craft interface has a four-line LCD display with six navigation buttons (see Figure). The display operates in one of two modes:

- Idle mode—Default mode that displays the current system status.
- Alarm mode—Displays alarm conditions whenever the red or yellow alarm LED is lit.

Figure 12: LCD Display and Navigation Buttons

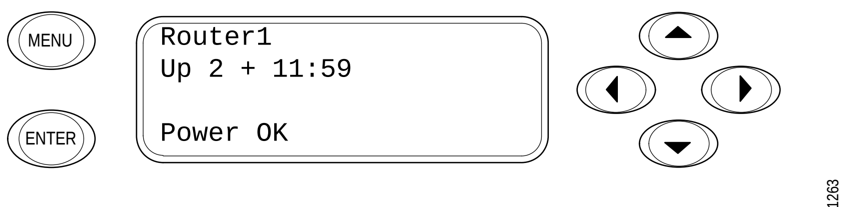


Idle Mode

Idle mode is the default mode of the LCD display. In this mode, the screen displays current system status (see Figure 13):

- First line—The name of the router.
- Second line—The number of days, hours,and minutes that the router has been running.
- Third and fourth lines—Status messages, which rotate at two-second intervals. These messages can be temporarily interrupted during special situations involving hot removal or hot insertion of system components.

Figure 13: LCD Screen in Idle Mode



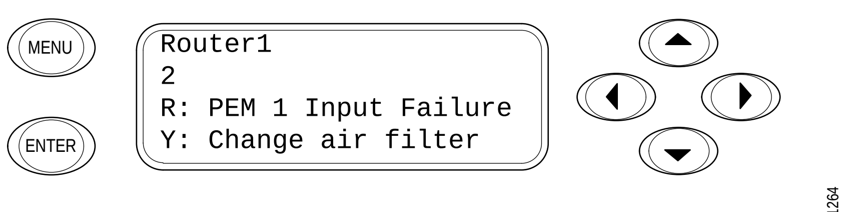
You can add a message that alternates every two seconds with the default status messages by issuing the setchassisdisplaymessage command. For more information, see the *JUNOS Internet Software Operational Mode Command Reference.*

Alarm Mode

When a red or yellow alarm occurs, alarm mode preempts idle mode, displaying a message to alert you of serious alarm conditions. In alarm mode, the screen displays the following information (see Figure 14):

- First line—The name of the router.
- Second line—The number of alarms active on the router.
- Third and fourth lines—Individual alarms, with the most severe condition shown first. Each line indicates whether the alarm is a red (R) or yellow (Y) alarm.

Figure 14: LCD Screen in Alarm Mode



For a list of alarm mode message types, see Table 33 on page 234 and Table 34 on page 234.

Host Module LEDs

Three LEDs—one green MASTER, one green ONLINE, and one red OFFLINE—located on the upper right of the craft interface indicate the status of each host module. The LEDs marked HOST0 show the status of the Routing Engine in slot RE0 and the MCS in slot MCS0. The LEDs marked HOST1 show the status of the Routing Engine in slot RE1 and the MCS in slot MCS1. The host module LEDs are located on the upper right of the craft interface.

Table 7 describes the functions of the host module LEDs.

Table 7: Host Module LEDs

Label	Shape	Color	State	Description
MASTER	○	Green	On steadily	Host module (Routing Engine and MCS) functioning as master
ONLINE	○	Green	On steadily	Host module present and operational
			Blinking	Host module starting up
OFFLINE	○	Red	On steadily	Host module not present, or present but not operational

FPC LEDs and Offline Button

Each FPC slot has two LEDs—one green OK and one red FAIL—and one offline button, which are located along the bottom of the craft interface. The LEDs indicate the status of the FPCs. Only one state at a time can occur for each FPC. You use the offline button to take an FPC offline before removing it.

Table 8 describes the functions of the FPC LEDs and offline button.

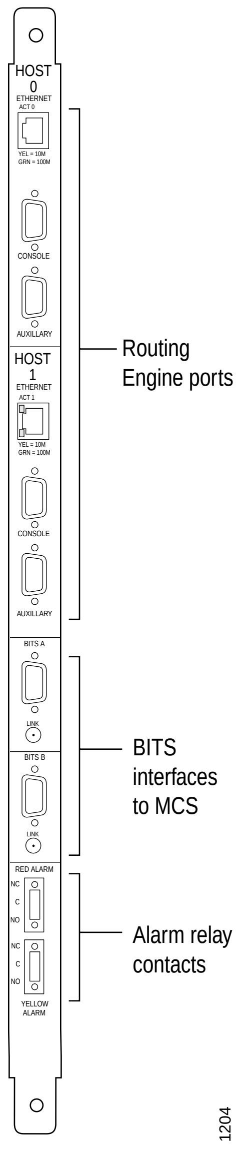
Table 8: FPC LEDs and Offline Button

Label	Shape	Color	State	Description
FPC LEDs (Only one of the following states can occur at a time.)				
OK	□	Green	On steadily	FPC functioning normally
			Blinking	FPC starting up
FAIL	○	Red	On steadily	FPC failure
numbered FPC0-FPC7	FPC0-7	—	—	Press this button to take an FPC offline. Press and hold for three seconds until the FPC OK LED turns off, then remove the FPC.

Connector Interface Panel (CIP)

The Connector Interface Panel (CIP) is located at the left side of the FPC card cage (see Figure 15). The CIP consists of connectors for the Routing Engines, Building Integrated Timing Source (BITS) interfaces for the MCS, and alarm relay contacts.

Figure 15: Connector Interface Panel



Routing Engine Ports

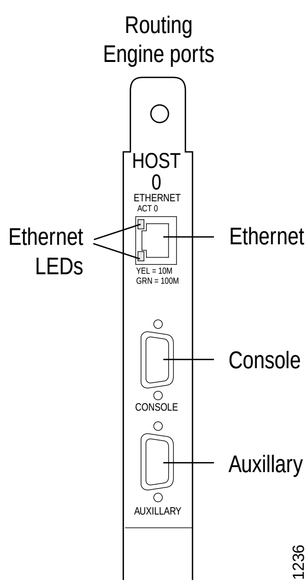
The CIP has two sets of ports for connecting the Routing Engines to external management devices (see Figure 15). You can use the command-line interface on these management devices to configure the router.

The upper set of ports, marked HOST0, connects to the Routing Engine in the RE0 slot, and the lower set, marked HOST1, connects to the Routing Engine in the RE1 slot. Each set includes the following ports (see Figure 16):

- Console port—Used to connect a system console to a Routing Engine with an RS-232 (EIA-232) serial cable.
- Auxiliary port—Used to connect a laptop or modem to a Routing Engine with an RS-232 (EIA-232) serial cable.
- Ethernet management port—Used to connect a Routing Engine to a management LAN (or any other device that plugs into an Ethernet connection) for out-of-band management of the router. The Ethernet port can be 10 or 100 Mbps and uses an autosensing RJ-45 connector.

  The Ethernet management port has two LEDs, which indicate the type of connection in use. A yellow LED lights when a 10-Mbps connection is in use, and a green LED lights when a 100-Mbps connection is in use.

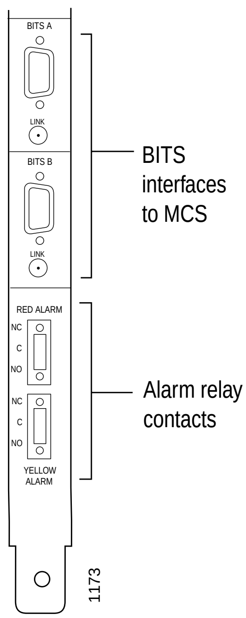
Figure 16: Routing Engine Ports on Connector Interface Panel



BITS Interfaces

In the center of the CIP are two ports labeled BITSA and BITSB (see Figure 17). The router does not support BITS input, so these ports currently do not function.

Figure 17: BITS Interfaces and Alarm Relay Contacts



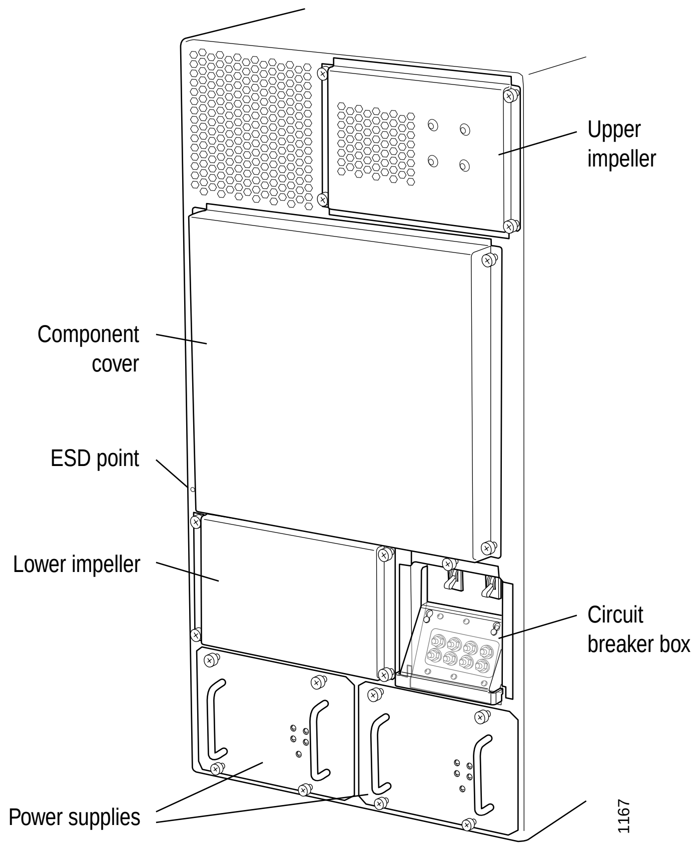
Alarm Relay Contacts

The CIP has two sets of relay contacts for connecting the router to external alarm devices. Whenever a system condition triggers either the red or yellow alarm on the craft interface, the alarm relay contacts also are activated. The alarm relay contacts are located below the BITS interfaces (see Figure 17).

Power Supplies

The router has two load-sharing pass through DC power supplies (see Figure 18). The power supplies are either original (see Figure 19) or enhanced (see Figure 20). The power supplies are located at the lower rear of the chassis, below the rear lower impeller and the router's on-board circuit breaker box. The power supplies are internally connected to the midplane, which delivers the power input from the circuit breaker box and distributes the different output voltages produced by the power supplies to the router's components, depending on their voltage requirements.

Figure 18: Rear of Chassis



The power supplies are fully redundant. If one power supply fails or is removed, the second power supply instantly assumes the entire electrical load. A single power supply can provide full power (up to 2600 W for the original power supply or 3200 W for the enhanced power supply) for as long as the system is operational. Redundancy is necessary only in case of power supply failure.

The router supports DC power supplies only— an original DC supply (see Figure 19), or an enhanced DC supply (see Figure 20). Power supplies are hot-removable and hot-insertable; the corresponding circuit breaker should be switched off before removing the power supply. Each power supply has handles to facilitate removal from the chassis.

The power supplies are cooled by air drawn through the chassis by the cooling system components.

Figure 19: Original DC Power Supply

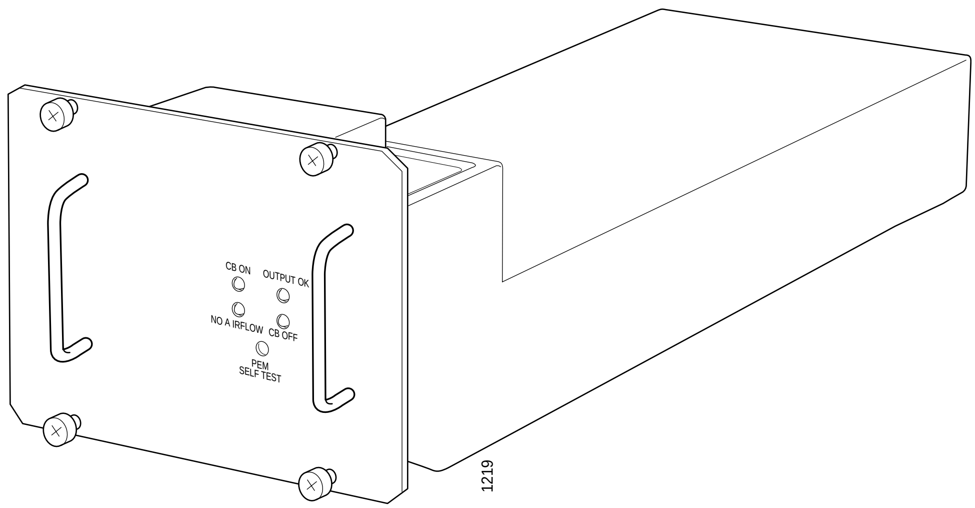
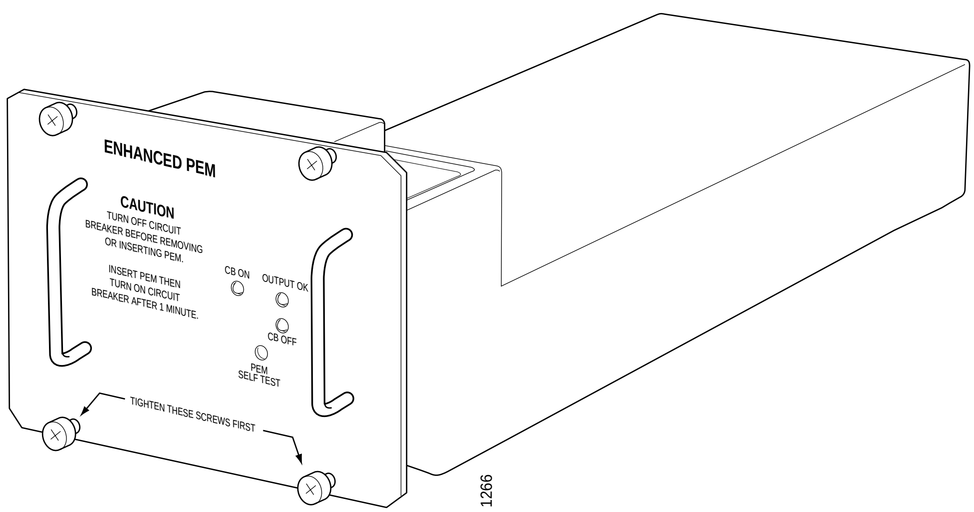


Figure 20: Enhanced DC Power Supply



Power Supply LEDs

Four LEDs on each power supply faceplate indicate the power supply’s status. In addition, a fail condition triggers the red alarm LED on the craft interface. Table 9 describes the power supply LEDs.

> **Note**
>
> The enhanced power supply does not have a NO AIRFLOW LED (see Figure 20).

Table 9: Power Supply LEDs

Label	Color	State	Description
CB ON	Green	On steadily	Power supply is inserted correctly and is receiving power. Circuit breaker is on.
OUTPUT OK	Blue	On steadily	Power supply is inserted and is functioning normally.
		Blinking	Power supply is not functioning, is going through startup, is not properly inserted, or airflow is not sufficient.
NO AIRFLOW (original power supply only)	Amber	On steadily	Power supply is inserted, but airflow around the power supply is not sufficient.
CB OFF	Amber	On steadily	Power supply is functioning, but the circuit breaker is off.

Power Supply Self-Test Button

Below the power supply LEDs is a self-test button that is used to test the power supply. The self-test button is for use by qualified service personnel only.

Power Supply Electrical Specifications

Table 10 lists the power supply electrical specifications for the original power supply. Table 11 lists the power supply electrical specifications for the enhanced power supply.

Table 10: Original Power Supply Electrical Specifications

Description	Specification
Power supply	2600 W maximum output; non-isolated
DC input voltage	Nominal: –48 VDC Operating range: –42 to –72 VDC
Input DC current rating	65 A @ –48 V
Output voltages	+ 48 V @ 8 A (cooling system), + 8 V @ 6 A (bias), –48 V @ 60 A

Table 11: Enhanced Power Supply Electrical Specifications

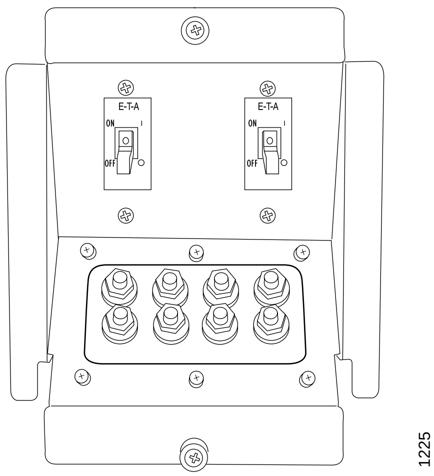
Description	Specification
Power supply	3200 W maximum output; non-isolated
DC input voltage	Nominal: –48 VDC Operating range: –42 to –72 VDC
Input DC current rating	80 A @ –48 V
Output voltages	+ 48 V @ 8 A (cooling system), + 8 V @ 6 A (bias), –48 V @ 75 A

Circuit Breaker Box

The power cables from the DC power source connect to the router’s onboard circuit breaker box, which is located on the rear of the chassis, above the right-hand power supply. The circuit breaker box provides two circuit breakers, one for each power supply (see Figure 21). Power must be connected from two DC sources for load sharing, one for each circuit breaker, for proper operation of the router.

Power cables are attached to the terminal studs on the circuit breaker box by cable lugs and washers. A grounding cable is attached to separate grounding points on the chassis above the circuit breaker box by bolts and washers. For information on power and grounding cable specifications, see “Power and Grounding Cable Specifications” on page 61.

Figure 21: Circuit Breaker Box



Fuses

The router has fuses for the FPCs, SFMs, MCS, and PCGs. The fuses are located in a fuse box on the rear of the midplane. To access the fuses, you remove the rear lower impeller assembly. The router uses Cooper Bussman brand GMT-type fuses.

Figure 22 shows the fuse box and the location of the fuse for each component. The fuse locations are also shown on a table attached to the midplane below the fuse box.

Figure 22: Fuse Locations

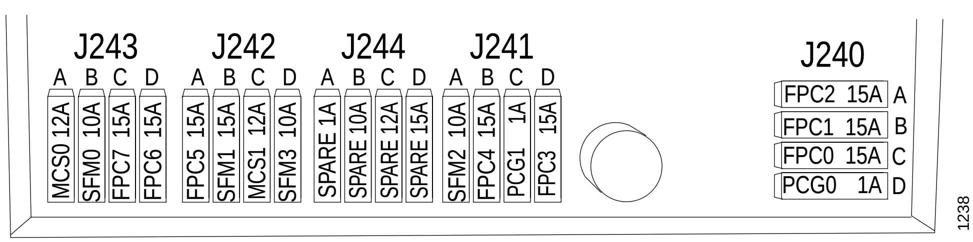


Table 12 lists fuse power ratings and specifications.

Table 12: Fuse Specifications

Description	Rating	Color	Quantity	Locations
FPC	15 A	Red and blue	9	J240 A, B, and C: J241 B and D J242 A J243 C and D J244 D (spare)
MCS	12 A	Yellow and green	3	J242 C J243 A J244 C (spare)
SFM	10 A	Red and white	5	J241 A J242 B and D J243 B J244 B (spare)
PCG	1 A	Gray	3	J240 D J241 C J244 A (spare)

Cooling System

The router's cooling system consists of two separate subsystems:

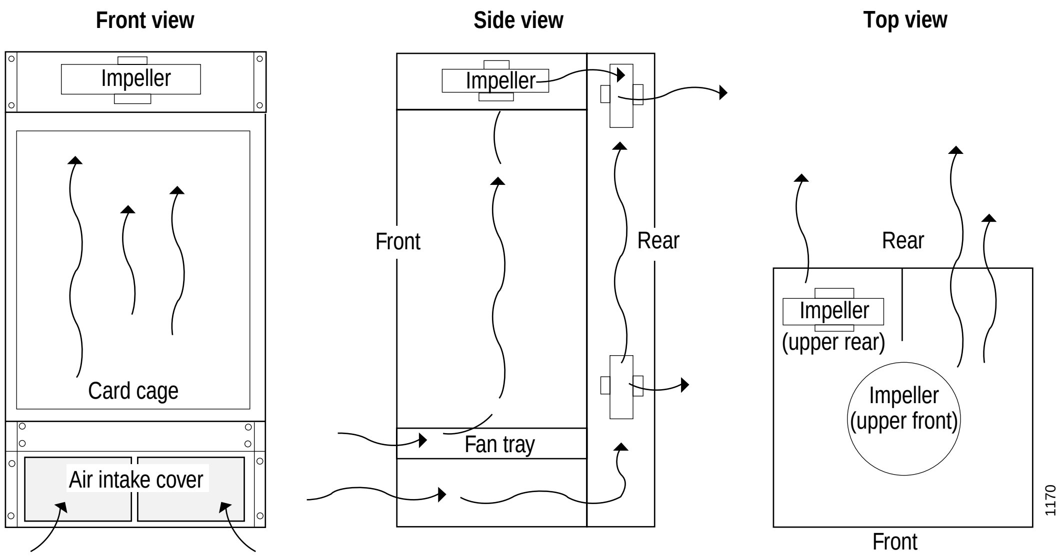
- Front Cooling Subsystem—An upper impeller and a lower fan tray cool the FPCs, the PICs and the midplane.
- Rear Cooling Subsystem—A pair of impellers cools the SFMs, the host module, the PCGs, and the power supplies.

The MCS monitors the temperature of the router's components. When the router is operating normally, the impellers and fans function at lower than full speed. If an impeller or fan fails or is removed, the temperature increases and the speed of the remaining impellers and fans is automatically adjusted to keep the temperature within the acceptable range.

The air intake for both cooling subsystems is located on the front of the chassis, below the FPC card cage. An air filter in front of the air intake prevents dust and other particles from entering the cooling system.

Figure shows airflow through the chassis and the location of the impellers and fan tray.

Figure 23: Air Flow through the Chassis



Front Cooling Subsystem

The front cooling subsystem consists of a large, central impeller that is located above the FPC card cage and a fan tray located below the FPC card cage. Together, they cool the FPCs and PICs.

The front impeller and fan tray are both hot-insertable and hot-removable.

Rear Cooling Subsystem

The rear cooling subsystem consists of a pair of impellers that are located at the upper right and lower left of the rear of the chassis. Together, they cool the SFMs, Routing Engine, MCS, and PCGs.

Each rear impeller is hot-insertable and hot-removable. The upper and lower impellers are not interchangeable.

The power supplies are cooled by air drawn through the chassis by the cooling system.

Air Filter

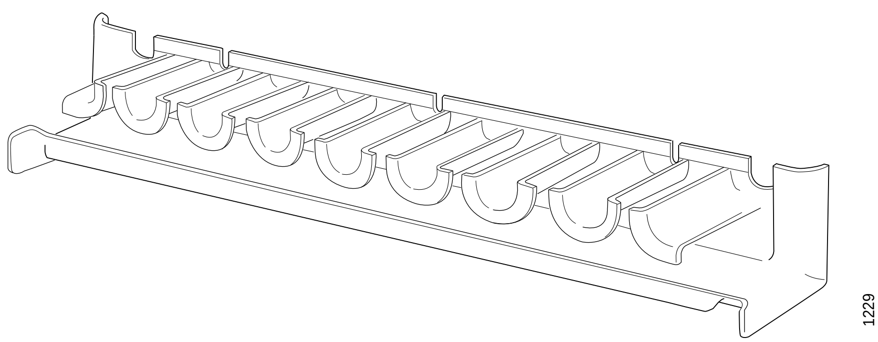
The air filter, located at the front of the air intake, prevents dust and other particles from entering the cooling system. Behind the air filter is a non-removable air intake cover which provides EMI shielding.

Caution Because the impellers and fans are quite powerful, it is important to keep the air filter in place while the router is operating. The impellers and fans could pull in foreign material, such as bits of wire, through an unfiltered air intake, resulting in damage to router components.

Cable Management System

The cable management system consists of a row of nine semi-circular plastic bobbins, mounted on the front of the chassis below the FPC card cage. The PIC cables wrap around the bobbins, keeping the cable organized and securely in place. The curvature of the bobbins also maintains the proper bend radius for optical PIC cables.

Figure 24: Cable Management System



Chapter 3

JUNOS Internet Software Overview

The JUNOS Internet software provides Internet Protocol routing software—as well as software for interface, network, and chassis management—especially designed for the large production networks typically supported by Internet Service Providers (ISPs).

The JUNOS Internet software runs on the router's Routing Engine. The software consists of processes that support Internet routing protocols, control the router's interfaces and the router chassis itself, and allow system management of the router. All these processes run on top of a kernel that provides the communication among all the processes and has a direct link to the Packet Forwarding Engine software. You use the JUNOS Internet software to configure the routing protocols that run on the router and properties of the interfaces in the router. After you have activated a software configuration, you use the JUNOS Internet software to monitor the protocol traffic passing through the router and to troubleshoot protocol and network connectivity problems.

This chapter discusses the following topics to provide an overview of the components of the JUNOS Internet software and of how to use the software:

For complete information about configuring the software, including examples, see the JUNOS Internet software configuration guides.

Routing Engine Software Components

The Routing Engine software consists of several software processes that control router functionality and a kernel that provides the communication among all the processes. This section describes each of the Routing Engine software components:

- SNMP and MIB II Processes on page 41
- Management Process on page 41
- Routing Engine Kernel

Routing Protocol Process

The JUNOS software routing protocol process controls the routing protocols that run on the router. The routing protocol process starts all configured routing protocols and handles all routing messages. It maintains one or more routing tables, which consolidate the routing information learned from all routing protocols into common tables. From this routing information, the routing protocol process determines the active routes to network destinations and installs these routes into the Routing Engine's forwarding table. Finally, the routing protocol process implements routing policy, which allows you to control the routing information that is transferred between the routing protocols and the routing table. Using routing policy, you can filter routing information so that only some of it is transferred, and you also can set properties associated with the routes.

For complete information about the routing protocol process, including routing protocols, routing and forwarding tables, routing policy, and interfaces, see the JUNOS Internet software configuration guides.

The following sections describe aspects of JUNOS routing protocol processe:

- Routing Protocols on page 38
- Routing and Forwarding Tables on page 39
- Routing Policy on page 40

Routing Protocols

The JUNOS Internet software implements full IP routing functionality, providing support for IP Version 4 (IPv4). The routing protocols are fully interoperable with existing IP routing protocols, and provide the scale and control necessary for the Internet core. The software provides support for the following routing and traffic engineering protocols:

- Unicast routing protocols
  - IS-IS—Intermediate System-to-Intermediate System is an interior gateway protocol (IGP) for IP networks that uses the shortest-path-first (SPF) algorithm (also referred to as the Dijkstra algorithm) to determine routes.
  - OSPF—Open Shortest Path First, Version 2, is an IGP that was developed for IP networks by the Internet Engineering Task Force (IETF). OSPF is a link-state protocol that makes routing decisions based on the SPF algorithm.
  - RIP—Routing Information Protocol, Version 2, is an IGP for IP networks based on the Bellman-Ford algorithm. RIP is a distance-vector protocol. The JUNOS RIP software is compatible with RIP Version 1.

  - BGP—Border Gateway Protocol, Version 4, is an Exterior Gateway Protocol (EGP) that guarantees loop-free exchange of routing information between routing domains (also called autonomous systems). BGP, in conjunction with JUNOS routing policy, provides a system of administrative checks and balances that can be used to implement peering and transit agreements.
  - ICMP—Internet Control Message Protocol router discovery allows hosts to discover the addresses of operational routers on the subnet.
- Multicast routing protocols
  - DVMRP—Distance Vector Multicast Routing Protocol is a dense-mode (flood-and-prune) multicast routing protocol.
  - PIM sparse mode and dense mode—Protocol-Independent Multicast is a multicast routing protocol. PIM sparse mode routes to multicast groups that might span wide-area and interdomain internetworks. PIM dense mode is a flood-and-prune protocol.
  - MSDP—Multicast Source Discovery Protocol allows multiple PIM sparse mode domains to be joined. A rendezvous point (RP) in a PIM sparse mode domain has a peering relationship with an RP in another domain, thereby discovering multicast sources from other domains.
  - IGMP—Internet Group Management Protocol, Versions 1 and 2, is used to manage membership in multicast groups.
  - SAP/SDP—Session Announcement Protocol and Session Description Protocol handle conference session announcements.
- Traffic engineering protocols
  - MPLS—Multiprotocol Label Switching allows you to manually or dynamically configure label-switched paths through a network. Using MPLS, you can control how traffic traverses the network by directing it through particular paths rather than relying on the IGP's least-cost algorithm to choose a path.
  - RSVP—The Resource Reservation Protocol, Version 1, provides a mechanism for engineering network traffic patterns that is independent of the shortest path determined by a routing protocol. RSVP itself is not a routing protocol, but is designed to operate with current and future unicast and multicast routing protocols. JUNOS RSVP software supports dynamic signaling for MPLS paths.
  - LDP—The Label Distribution Protocol provides a mechanism for distributing labels in non-traffic-engineered applications. LDP allows routers to establish label-switched paths (LSPs) through a network by mapping network-layer routing information directly to data-link layer switched paths. LSPs created by LDP can also traverse LSPs created by RSVP.

Routing and Forwarding Tables

A primary function of the JUNOS routing protocol process is to maintain the Routing Engine's routing tables and from these tables, to determine the active routes to network destinations. It then installs these routes into the Routing Engine's forwarding table. The JUNOS kernel then copies this forwarding table to the Packet Forwarding Engine.

More specifically, the routing protocol process maintains multiple routing tables. By default, it maintains the following three routing tables, and you can configure additional routing tables to meet your requirements.

- Unicast routing table—Stores routing information for all unicast routing protocols running on the router. IS-IS, OSPF, RIP, and BGP all store their routing information in this common routing table, and you can configure additional routes, such as static routes, to be included in this routing table. IS-IS, OSPF, RIP, and BGP use the routes in the unicast routing table when advertising routing information to their neighbors.

- Multicast routing table (cache)—Stores routing information for all the running multicast protocols. DVMRP and PIM both store their routing information in this common routing table, and you can configure additional routes to be included in this routing table.

- MPLS routing table—Stores MPLS label information.

With each routing table, the routing protocol process uses the collected routing information to determine active routes to network destinations. For unicast routes, the routing protocol process determines active routes by choosing the most preferred route, which is the route with the lowest preference value. By default, the route's preference value is simply a function of how the routing protocol process learned about the route. You can modify the default preference value using routing policy and with software configuration parameters.

For multicast traffic, the routing protocol process determines active routes based on traffic flow and other parameters specified by the multicast routing protocol algorithms. The routing protocol process then installs one or more active routes to each network destination into the Routing Engine forwarding table.

Routing Policy

By default, all routing protocols place their routes into the routing table. When advertising routes, the routing protocols, by default, advertise only a limited set of routes from the routing table. Specifically, each routing protocol exports only the active routes that were learned by that protocol. In addition, IGPs (IS-IS, OSPF, and RIP) export the direct (interface) routes for the interfaces on which the protocol is explicitly configured.

For each routing table, you can affect the routes that a protocol places into the table and the routes from the table that the protocol advertises by defining one or more routing policies and then applying them to the specific routing protocol.

Routing policies applied when the routing protocol places routes into the routing table are called *import policies* because the routes are being imported into the routing table. Policies applied when the routing protocol is advertising routes that are in the routing table are called *export policies* because the routes are being exported from the routing table. In other words, the terms import and export are used with respect to the routing table.

Routing policy allows you to control (filter) which routes are imported into the routing table and which routes are exported from the routing table. Routing policy also allows you to set the information associated with a route as it is being imported into or exported from the routing table. Applying routing policy to imported routes allows you to control the routes used to determine active routes. Applying routing policy to routes being exported from the routing table allows you to control the routes that a protocol advertises to its neighbors.

You implement routing policy by defining policies. A policy specifies the conditions to use to match a route and the action to perform on the route when a match occurs. For example, when a routing table imports routing information from a routing protocol, a routing policy might modify the route's preference, mark the route with a color to identify it and allow it to be manipulated at a later time, or prevent the route from even being installed in a routing table. When exporting routes from a routing table into a routing protocol, a policy might assign metric values, modify the BGP community information, tag the route with additional information, or prevent the route from being exported altogether. You also can define policies for redistributing the routes learned from one protocol into another protocol.

Interface Process

The JUNOS interface process allows you to configure and control the physical interface devices and logical interfaces in the router. You configure various interface properties such as the interface location (the slot in which the FPC is installed and the location on the FPC in which the PIC is installed), the interface type (such as SONET/SDH or ATM), encapsulation, and interface-specific properties. You can configure the interfaces that are currently present in the router, as well as interfaces that you might be adding.

The JUNOS interface process communicates with the interface process in the Packet Forwarding Engine through the JUNOS kernel, enabling the JUNOS Internet software to track the status and condition of the router's interfaces.

SNMP and MIB II Processes

The JUNOS Internet software supports the Simple Network Management Protocol (SNMP), Versions 1 and 2, which provides a mechanism for monitoring the state of the router. This software is controlled by the JUNOS SNMP and MIB II processes, which consist of an SNMP master agent and a MIB II agent.

Management Process

Within the JUNOS Internet software, a management process starts and monitors all the other software processes, as well as the command-line interface (CLI), which is the primary tool you use to control and monitor the JUNOS Internet software. The management process starts all the software processes and the CLI when the router boots. If a software process terminates for some reason, the management process makes all reasonable attempts to restart it.

Routing Engine Kernel

The Routing Engine kernel provides the underlying infrastructure for all the JUNOS software processes. It also provides the link among the routing protocol process' routing tables and the Routing Engine's forwarding table. Additionally, it conducts communication with the Packet Forwarding Engine, including keeping the Packet Forwarding Engine's copy of the forwarding table synchronized with the master copy in the Routing Engine.

Tools for Accessing and Controlling the Software

The primary means of accessing and controlling the JUNOS Internet software is the CLI.

The router provides three ports on the craft interface for connecting external management devices to the Routing Engine and hence to the JUNOS Internet software:

- Ethernet management (MGMT) port—Connects the Routing Engine to a management LAN (or any other device that plugs into an Ethernet connection) for out-of-band management of the router. The Ethernet port can be 10 or 100 Mbps and uses an autosensing RJ-45 connector.

- Console (CONSOLE) port—Connects a system console to the Routing Engine with RS-232 serial cable.

- Auxiliary (AUX/MODEM) port—Connects a laptop or modem to the Routing Engine with RS-232 serial cable.

The CLI is the interface to the JUNOS Internet software that you use whenever you access the router from the console or through a remote network connection.The CLI provides commands used to perform various tasks, including configuring the JUNOS Internet software and monitoring and troubleshooting the software, network connectivity, and the router hardware.

The JUNOS CLI is a straightforward command interface. You type commands on a single line, and enter the commands by pressing the Enter key. The CLI provides command help and command completion, and also provides Emacs-style keyboard sequences that allow you to move around on a command line and scroll through a buffer that contains recently executed commands.

Software Monitoring Tools

You can monitor and troubleshoot the software, routing protocols, network connectivity, and hardware by running commands from the CLI. The CLI provides commands that let you display information in the routing tables, display routing protocol–specific information, and check network connectivity using the ping and traceroute commands.

The JUNOS Internet software includes Simple Network Management Protocol (SNMP) software, which allows you to manage routers. The SNMP software consists of an SNMP master agent and a MIB II agent, and provides full support for MIB II SNMP Version 1 traps and Version 2 notifications, and SNMP Version 1 Get and GetNext requests, and Version 2 GetBulk requests.

The software also supports tracing and logging operations, which allow you to track events that occur in the router—both normal router operations and error conditions—and to track the packets that are generated by or pass through the router. Logging operations use a syslog-like mechanism to record systemwide, high-level operations, such as interfaces going up or down and users logging into or out of the router. Tracing operations record more detailed messages about the operation of routing protocols, such as the various types of routing protocol packets sent and received, and routing policy actions.

Software Installation and Upgrade Procedures

The JUNOS software is preinstalled in the router. To upgrade the software, you copy a set of software images over the network to the router's flash disk using the CLI. The JUNOS Internet software set consists of several images that are provided in individual packages or as a single bundle. You normally upgrade all packages simultaneously. For information about installing and upgrading JUNOS software, see the JUNOS Internet software configuration guides.

Chapter 4

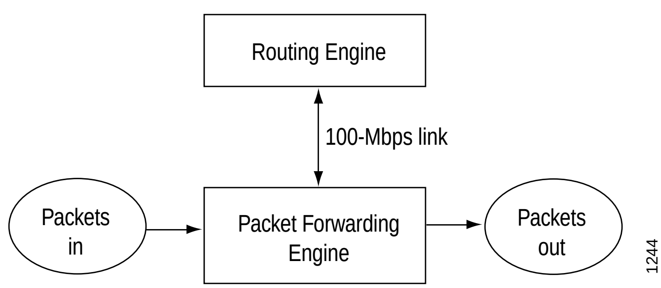
System Architecture Overview

The router consists of two major architectural components:

- Packet Forwarding Engine (PFE)—This high-performance, ASIC-based component provides Layer 2 and Layer 3 packet switching, route lookups, and packet forwarding.
- Routing Engine—Provides Layer 3 routing services and network management.

The Packet Forwarding Engine and the Routing Engine perform their primary tasks independently, though they constantly communicate through a 100-Mbps internal link. This arrangement provides streamlined forwarding and routing control and the capability to run Internet-scale backbone networks at high speeds. Figure illustrates the relationship between the Packet Forwarding Engine and the Routing Engine.

Figure 25: Router Architecture



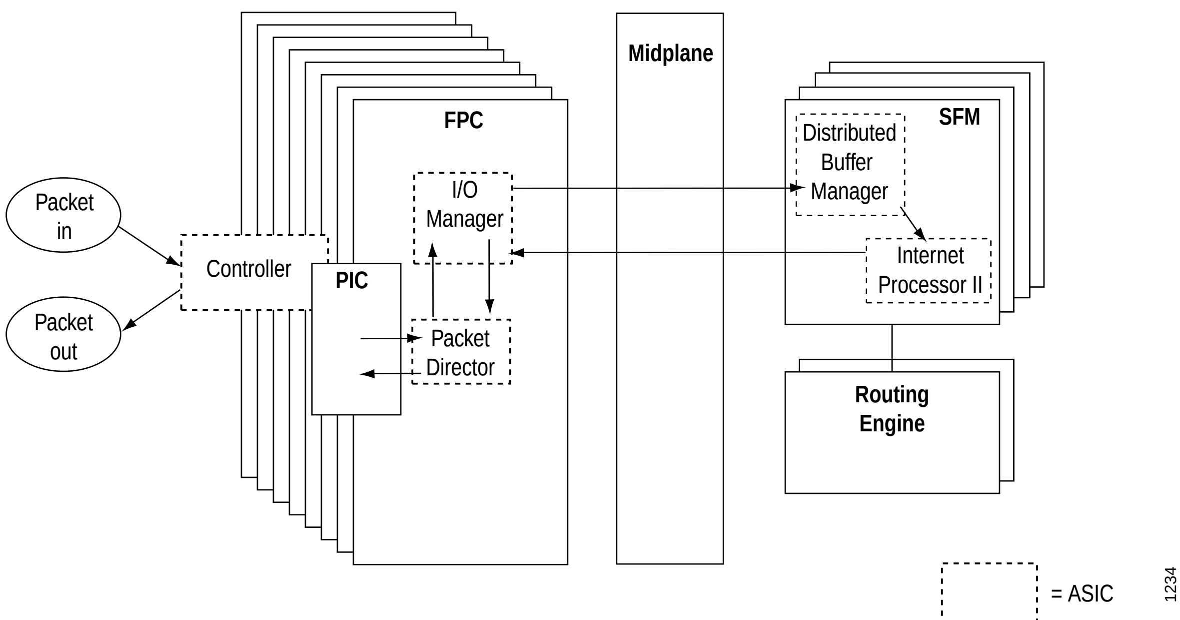
Packet Forwarding Engine

The Packet Forwarding Engine provides Layer 2 and Layer 3 packet switching. The Packet Forwarding Engine can forward up to 160 million packets per second for all packet sizes, which exceeds the line speed of 32 OC-48 lines. The aggregate bandwidth for the router is 160 Gbps simplex or 80 Gbps full duplex (10 Gbps per installed FPC). The Packet Forwarding Engine is implemented in ASICs and consists of a shared memory design with a centralized route lookup engine.

The Packet Forwarding Engine consists of the following components (see Figure):

- Midplane—Provides the interconnection between the FPCs and SFMs, as well as other system components.
- SFMs—Host the Internet Processor II ASICs, which make forwarding decisions, and the Distributed Buffer Manager ASICs, which distribute data cells throughout memory and forward notification of outgoing packets.
- FPCs—Provide shared memory and connect the PICs to the rest of the router so that packets can be routed to the appropriate destination port. Each FPC hosts a Packet Director ASIC, which distributes incoming data packets between the SFMs, and an I/O Manager ASIC, which divides incoming data packets into 64-byte memory blocks (cells) and reassembles the cells into data packets when they are ready for transmission.
- PICs—Each PIC hosts a controller ASIC that performs control functions tailored to the PIC's media type. PICs provide a complete range of fiber optic and digital transmission interfaces to the network.

Figure 26: Packet Forwarding Engine Components and Data Flow



Data Flow through the Packet Forwarding Engine

To ensure efficient data packet movement through the system, the router is designed so that ASICs on the hardware components handle the forwarding of data packets. Data flows through the Packet Forwarding Engine in the following sequence (see Figure):

1. Packets arrive at an incoming PIC interface.
2. The PIC passes the packets to the FPC, where the Packet Director ASIC distributes them among the I/O Manager ASICs.

3. The I/O Manager ASIC processes the packet headers, divides the packets into 64-byte data cells and passes them through the midplane to the SFM.

4. The Distributed Buffer Manager ASIC on the SFM distributes the data cells throughout memory banks that are shared over all the FPCs.

5. The Internet Processor II ASIC on the SFM performs route lookups and makes forwarding decisions.

6. The Internet Processor II ASIC notifies a second Distributed Buffer Manager ASIC on the SFM, which forwards the notification to the outbound interface.

7. The I/O Manager ASIC on the FPC reassembles data cells in shared memory into data packets as they are ready for transmission and passes them through the Packet Director ASIC to the outbound PIC.

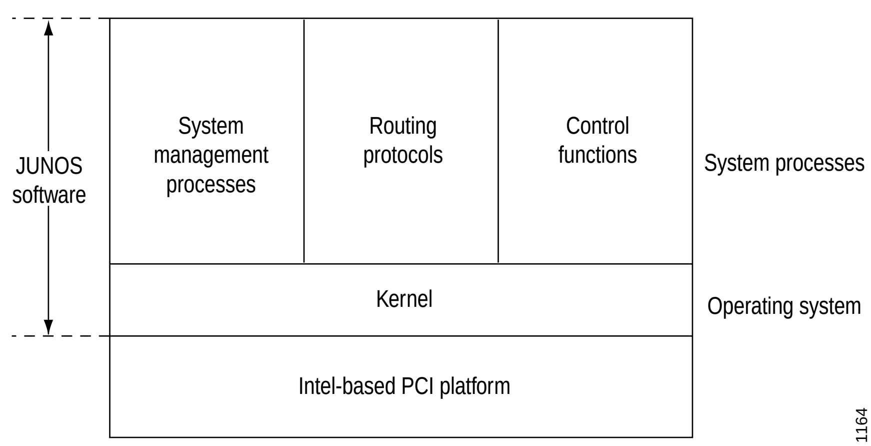
8. The outbound PIC transmits the data packets.

Routing Engine

The Routing Engine consists of JUNOS Internet software running on an Intel-based PCI platform. The JUNOS Internet software was developed and optimized by Juniper Networks to scale to large numbers of network interfaces and routes. The software consists of a series of system processes running in protected memory modules on top of an independent operating system. The JUNOS kernel supports JUNOS system processes which handle system management processes, routing protocols, and control functions (see Figure).

The Routing Engine has a dedicated 100-Mbps internal connection to the Packet Forwarding Engine.

Figure 27: Routing Engine Architecture



Routing Engine Functions

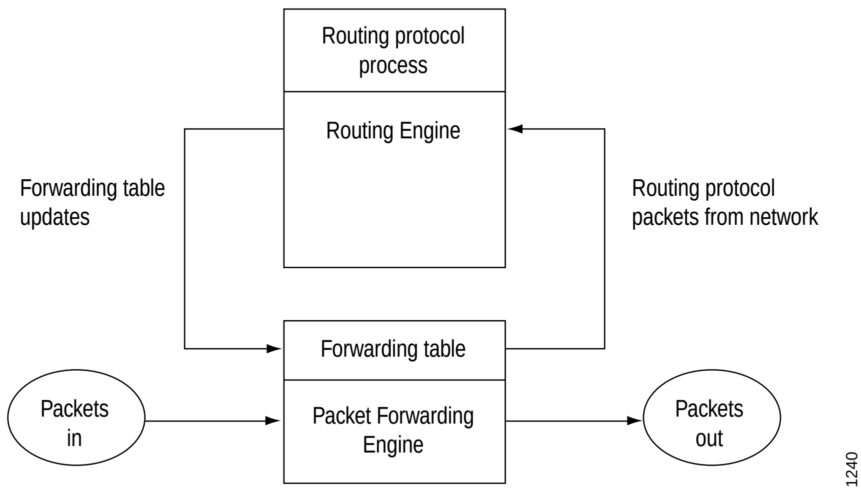
The Routing Engine handles all the routing protocol processes, as well as other software processes that control the router's interfaces, the chassis components, system management, and user access to the router. These routing and software processes run on top of a kernel that interacts with the Packet Forwarding Engine.

The Routing Engine provides the following features:

- Process routing protocol packets—All routing protocol packets from the network are directed to the Routing Engine, and do not delay the Packet Forwarding Engine.
- Software modularity—By dividing the different software functionalities into separate processes, the failure of one process is isolated from others and has little or no effect on the other software processes.
- In-depth Internet functionality—Each routing protocol is implemented with a complete set of Internet features, and provides full flexibility for advertising, filtering, and modifying routes. Routing policies are set according to route parameters (for example, prefix, prefix lengths, and BGP attributes).
- Scalability—The JUNOS routing tables have been designed to hold all the routes in current networks with ample capacity for expansion. Additionally, the JUNOS Internet software can efficiently support large numbers of interfaces and virtual circuits.
- Management interface—Different levels of system management practices are provided, including a command-line interface, the craft interface, and SNMP.
- Storage and change management—Configuration files, system images, and microcode can be held and maintained in primary and secondary storage systems, permitting local or remote upgrades.
- Monitoring efficiency and flexibility—The router permits alarm handling and packet counting, for example, on every port, without adversely affecting packet forwarding performance.

The Routing Engine constructs and maintains one or more routing tables (see Figure). From the routing tables, the Routing Engine derives a table of active routes, called the forwarding table, which is then copied into the Packet Forwarding Engine. The design of the Internet Processor II ASIC allows the forwarding table in the Packet Forwarding Engine to be updated without interrupting forwarding performance.

Figure 28: Control Packet Handling: Routing and Forwarding Table Updates



Part 2
Initial Installation

Chapter 5
Prepare the Site

This chapter describes how to prepare your site so that you can install an M160 Internet Backbone Router, discussing the following topics:

Rack Requirements

The router must be installed in a rack. It can be mounted in many types of racks, including the following:

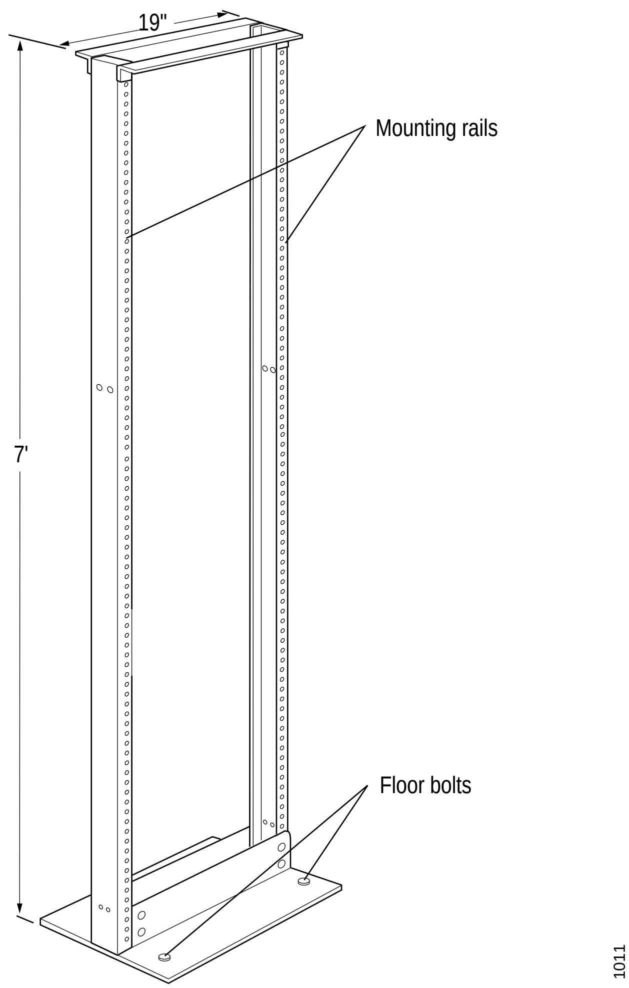
- Standard 19-in. equipment rack
- Standard Telco rack (4-post)
- Center-mount rack

Figure illustrates a typical center-mount rack.

Select a rack that satisfies the following requirements:

- Alignment of Rack-Mounting Holes on page 54
- Rack Size and Strength on page 55
- Chassis Clearance Requirements on page 55

Figure 29: Typical Center-Mount Rack



Alignment of Rack-Mounting Holes

The mounting holes on the rack rails must align with the mounting holes on the chassis mounting ears. The chassis is equipped with two different sets of vertical mounting ears, one set intended for center-mount racks and one set intended for front-mount racks. Table 13 lists the spacing between mounting holes on these ears for each type of rack.

Table 13: Chassis Rack Mounting Hole Spacing

Type of Rack	Chassis Hole Spacing
Center mount	5.25 inches, 7 inches
Front mount	5.25 inches

Rack Size and Strength

The rack must be large enough to accommodate the router's external chassis dimensions—35 in. (89 cm) high, 17.5 in. (44.5 cm) wide, and 29 in. (73 cm) deep, plus the recommended air flow clearances between the system and the rack, as described in "Air Flow Clearance" on page 56.

Note

The router may not fit into an 800 mm deep cabinet.

The router is 19 in. (48.3 cm) wide to the tips of the rack-mounting ears.

The rack must be strong enough to support the weight of the fully configured system, up to about 370 lbs (168 kg). If you stack two routers in one standard rack, the rack must be capable of supporting about 740 lbs (336 kg).

Secure Racks

When planning rack space for the router, follow these guidelines for securing racks:

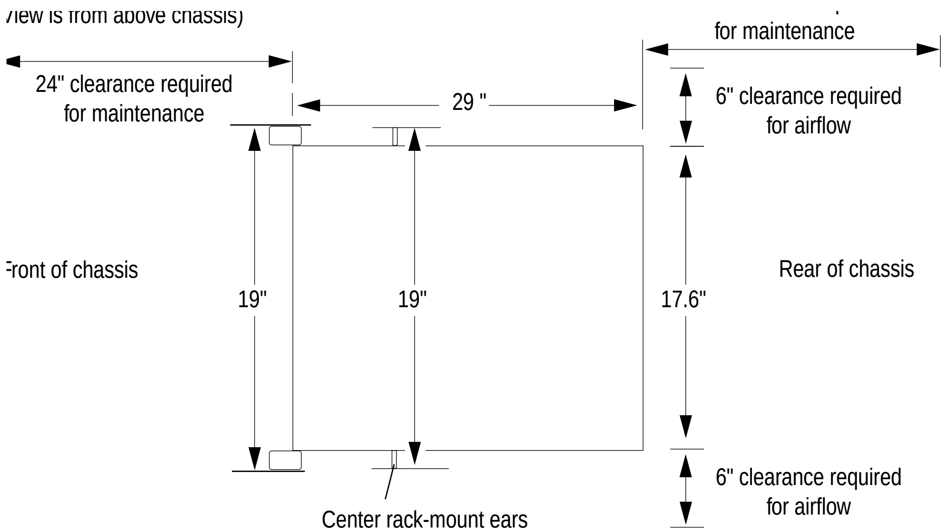
- Secure the rack to the structure of the building.
- If your geographical area is subject to earthquakes, be sure that the rack is bolted to the floor.
- To maximally stabilize the system, secure the rack to ceiling brackets.

For information regarding rack mounting requirements and safety, see "Rack-Mounting Requirements and Warnings" on page 93.

Chassis Clearance Requirements

When planning the installation site, you need to allow sufficient clearance around the rack for maintenance access (see Figure), at least 24 in. (61 cm) in front of and behind the rack. In the front, you must allow adequate space to remove and install FPCs, PICs and the fan tray. In the rear, you must allow adequate space to remove and install the SFMs, Routing Engine, power supplies, and other components.

Figure 30: Chassis Outer Dimensions and Clearance Requirements



Air Flow Clearance

The cooling system must have unrestricted air flow to function properly. Allow at least 6 in. of clearance on both sides of the chassis.

> **Note**
> Each FPC slot in the router must have an FPC or FPC blank panel installed to properly channel cooling air. The FPCs channel air so that it circulates properly throughout the card cage, thus maintaining the temperature at an acceptable level.

Site Environmental Requirements

Table 14 lists the site environmental specifications required by the router.

Make sure that the air circulating through the router is as dust-free as possible. Dust can clog the air filters, causing the cooling system to operate less efficiently. You should frequently check the air filter, which covers the air intake vents for all three cooling subsystems, and clean it if necessary.

Table 14: Site Environment Specifications

Description	Specification
Altitude	No performance degradation to 10,000 ft. (3048 m)
Relative humidity	Normal operation ensured in relative humidity range of 5% to 90%, noncondensing
Temperature	Normal operation ensured in temperature range of 0°C (32°F) to +40°C (+104°F)
Shock	Tested to meet Bellcore Zone 4 earthquake requirements
Thermal output	9400 BTU/hr

Fire Safety

In the event of a fire emergency involving routers and other network equipment, the safety of people is the primary concern. You should establish procedures for protecting people in the event of a fire emergency, provide safety training, and properly provision fire-control equipment and fire extinguishers.

In addition, you should establish procedures to protect your equipment in the event of a fire emergency. Juniper Networks products should be installed in an environment suitable for electronic equipment. We recommend that fire suppression equipment be available in the event of a fire in the vicinity of the equipment, and that all local fire, safety, and electrical codes and ordinances be observed when installing and operating your equipment.

Fire Suppression

In the event of an electrical hazard or an electrical fire, you should first turn power off to the equipment at the source. Then, use a Type C fire extinguisher, which uses noncorrosive fire retardants, to extinguish the fire. For more information about fire extinguishers, see “Fire Suppression Equipment”.

Fire Suppression Equipment

Type C fire extinguishers, which use noncorrosive fire retardants such as carbon dioxide (CO_2) and Halotron™, are most effective for suppressing electrical fires. Type C fire extinguishers displace the oxygen from the point of combustion to eliminate the fire. For extinguishing fire on or around equipment that draws air from the environment for cooling, you should use this type of inert oxygen displacement extinguisher instead of an extinguisher that leave residues on equipment.

Do not use multipurpose Type ABC chemical fire extinguishers (dry chemical fire extinguishers) near Juniper Networks equipment. The primary ingredient in these fire extinguishers is monoammonium phosphate, which is very sticky and difficult to clean. In addition, in minute amounts of moisture, monoammonium phosphate can become highly corrosive and corrodes most metals.

Any equipment in a room in which a chemical fire extinguisher has been discharged is subject to premature failure and unreliable operation. The equipment is considered to be irreparably damaged.

> **Note**
> To keep warranties effective, do not use a dry chemical fire extinguisher to control a fire at or near a Juniper Networks router. If a dry chemical fire extinguisher is used, the unit is no longer eligible for coverage under a service agreement.

We recommend that you dispose of any irreparably damaged equipment in an environmentally responsible manner.

Power Requirements and Specifications

The router has two load-sharing pass-through DC power supplies. The power supplies are either original (see Figure 31) or enhanced (see Figure 32).Each power supply requires a dedicated DC power source.

DC power is normally carried around the site through a main conduit to frame-mounted DC power distribution panels, one of which might be located at the top of the rack where the router is to be installed. A pair of cables (–48V and RTN) connects each DC supply to the power distribution panel. Grounding points are provided on the rear of the router chassis.

For electrical safety information, see “Product Disposal Warning” on page 106.

This section describes the following:

- Power Supply Load Sharing on page 59
- Power Supply Redundancy and Replaceability on page 60
- Power Supply LEDs on page 60
- PEM Self-Test Button on page 60
- Power and Grounding Cable Specifications on page 61
- System Power Requirements on page 63
- Power Supply Electrical Specifications on page 64

Figure 31: Original DC Power Supply

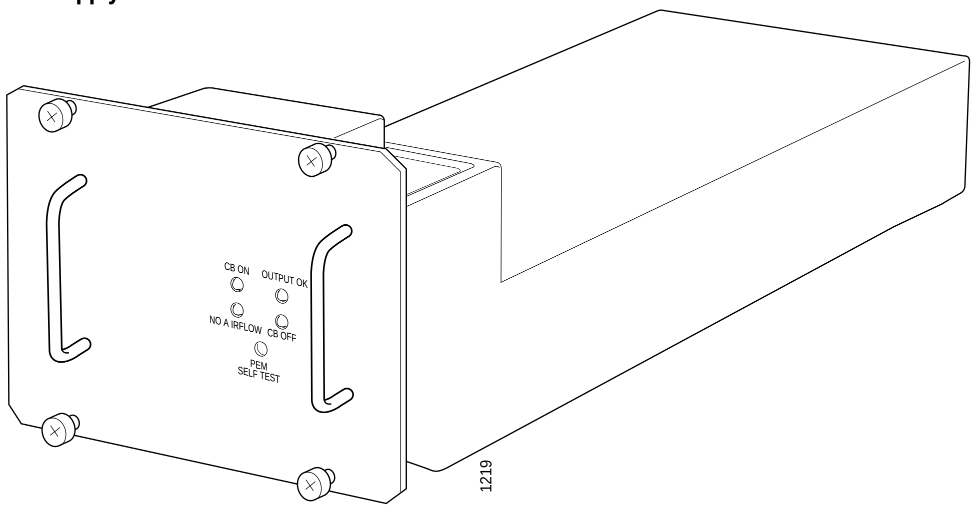
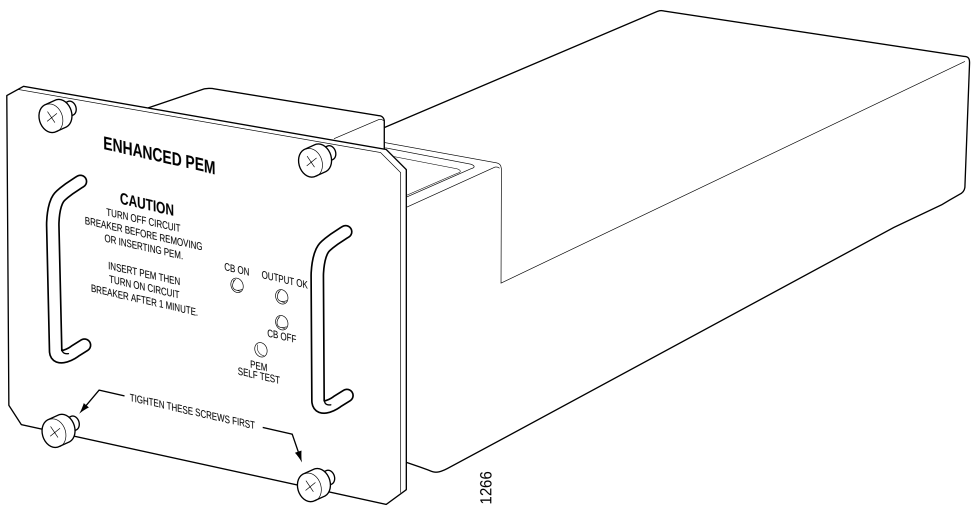


Figure 32: Enhanced DC Power Supply



Power Supply Load Sharing

When the router is operating normally and both power supplies are switched on, load-sharing between them occurs automatically.

Power Supply Redundancy and Replaceability

The router operates with two redundant power supplies. A single power supply unit can provide full power for as long as the system is operational. When power is shut off to one power supply, the other power supply immediately assumes the entire electrical load for the system.

Power supplies are hot-insertable and hot-removable, so you can remove one of them without powering down the system.

Power Supply LEDs

The faceplate on each power supply unit has four LEDs that report the status of the power supply:

- Green CB ON LED—Lights when the power supply is properly installed and the circuit breaker is on.
- Blue OUTPUT OK LED—Lights when the power supply is properly installed and output voltages are within acceptable ranges, and when airflow is sufficient. Blinks when the power supply is improperly installed, when there is no input power, or when airflow is insufficient.
- Amber NO AIRFLOW LED (original power supply only)—Lights when airflow to the power supply is insufficient.
- Amber CB OFF LED—Lights when the circuit breaker is off, but the redundant power supply is installed and working.

In addition, when one or both of the power supplies are operating within an unacceptable voltage range, the red alarm LED lights on the craft interface, and the alarm relay contacts on the craft interface are activated.

Note

The enhanced power supply does not have a NO AIRFLOW LED (see Figure 32).

PEM Self-Test Button

Below the power supply LEDs is a button labeled PEM SELF-TEST, used to perform a diagnostic test on the power supply. Only qualified service personnel should use the self-test button.

Power and Grounding Cable Specifications

The DC power cables attach to the router's on-board circuit breaker box terminal studs with cable lugs (see Figure and Figure). DC power cables should be 4 AWG, equal length for load sharing. Power cables are not provided. Table 15 shows specifications for power and grounding cables.

The circuit breaker box has two sets of terminal studs for each power supply; one input and one return. These are 1/4–20 UNC terminal studs at 0.625-in. (15.86-mm) centers. Cable lugs have two holes that fit over the terminal studs. During installation, you secure the cable lugs onto the terminal studs—first with the washers, then the nuts. A plastic protective shield covers the circuit breaker box terminal studs. You remove this shield before securing the lugs to the terminal studs.

The grounding cable attaches to the chassis grounding points, located above the circuit breaker box. The grounding cable should be 4 AWG, high-strand-count wire cable, with two leads. The grounding cable is not provided.

The grounding points are internally threaded inserts (PEM nuts) at 0.625-in. (15.86-mm) centers. The grounding cable lug has two holes that attach to the grounding points with 1/4-20 UNC bolts. During installation, you secure the grounding lug to the nuts—first with the washers, then with the bolts. The grounding cable must be connected to a proper earth ground for the router's two power sources.

Figure 33: Power and Grounding Cable Lugs

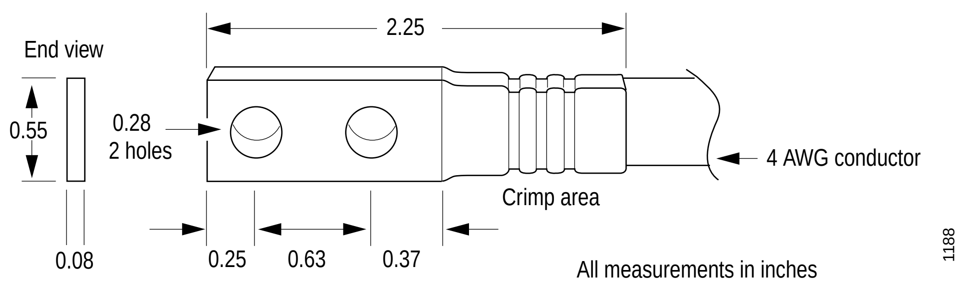


Figure 34: Circuit Breaker Box Power Cable Connectors

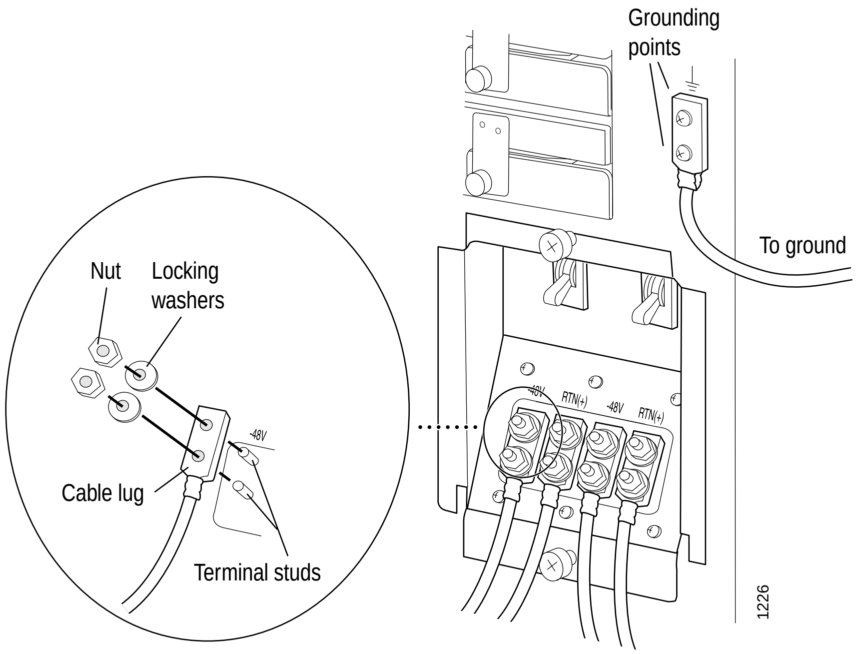


Table 15: Power and Grounding Cable Specifications

Cable Type	Cable Specification	Supplied	Maximum Equal Length	Other Parts Required	Connector Specification
Power cables	4 AWG wire cables	No	None	Eight washers and nuts	Cable lug; dual hole, sized to fit 1/4-20 UNC terminal studs at 15.86-mm (0.625-inch) center line
Grounding cable	4 AWG wire cable	No	None	Two washers and bolts	Cable lug; dual hole, sized to fit 1/4-20 UNC grounding studs at 15.86-mm (0.625-inch) center line

Note

The DC power supplies are to be installed only in restricted areas, such as dedicated equipment rooms and equipment closets, in accordance with Articles 110-16, 110-17, and 110-18 of the National Electrical Code, ANSI/NFPA 70.

Note

For field-wiring connections, use copper conductors only.

System Power Requirements

Table 16 lists the power requirements for the individual hardware components when the router is operating under typical voltage conditions.

Table 16: System Power Requirements

Component	Power (Amps)
Base system (includes cooling system, power supplies, and craft interface but does not include FPCs, SFMs, host module, PCGs, or PICs)	7-10 ADC/48 V
FPC	2.4 ADC/48 V
SFM	1.3 ADC/48 V
Host module (Routing Engine and MCS)	1.3 ADC/48 V
PCG	0.2 ADC/48 V
Dense FE	0.94 ADC/48 V
ATM OC-12 PIC	0.625 ADC/48 V
Channelized OC-12 PIC	0.625 ADC/48 V
Gigabit Ethernet PIC	0.325 ADC/48 V
SONET/SDH OC-12 PIC	0.475 ADC/48 V
SONET/SDH OC-48 PIC	0.475 ADC/48 V
SONET/SDH OC-192 Interface	3.5 ADC/48 V
Tunnel PIC	0.625 ADC/48 V

Power Consumption Examples

The following examples illustrate how you can use the information in Table 16 to calculate power consumption for various configurations, input current from a different source voltage, and thermal output:

- Power consumption for minimum configuration:

  Base system + 1 FPC + 1 SFM + 1 host module + 1 PCG + 4 (ATM OC-12) PICs =
  7 A + 2.4 A + 1.3 A + 1.3 A + 0.2 A + 4(0.625 A) =
  7 A + 2.4 A + 1.3 A + 1.3 A + 0.2 A + 2.5 A = 14.7 A@48 V

- Power consumption for maximum configuration:

  Base system + 8 FPCs + 4 SFMs + 2 host modules + 2 PCGs + 32 (ATM OC-12) PICs =
  10 A + 8(2.4 A)+ 4(1.3 A) + 2(1.3 A)+ 2(0.2 A) + 32(0.625) =
  10 A + 19.2 A + 5.2 A + 2.6 A + 0.4 A + 20 A = 57.4 A@48 V

- Input current from a DC source other than 48 V (based on maximum configuration):

  54 VDC input x input current X = 48 VDC x input current Y
  54 x X = 48 x 57.4
  X = 48 x 57.4/54 = 51 A

- Calculating thermal output (based on maximum configuration):

  Watts DC/0.293 = BTU/hr
  48 x 57.4/0.293 = 9403 BTU/hr

> **Note**
> If you plan to operate the router using the maximum configuration, we recommend you provision at least 70 A @ 48 VDC. Doing so allows you to operate the router using any configuration without upgrading the power infrastructure, and allows the router to function at full capacity using one power supply.

Power Supply Electrical Specifications

Table 10 on page 32 lists the power supply electrical specifications for the original power supply. Table 11 on page 32 lists the power supply electrical specifications for the enhanced power supply.

Table 15 lists DC power cable specifications. The circuit breakers for the power supplies are located in the router's onboard circuit breaker box.

System Grounding Guidelines

To meet safety and EMI requirements and to ensure proper operation, the router must be adequately grounded before power is connected. Two internally threaded inserts (PEM nuts) are provided on the right rear of the chassis for connecting the router to earth ground.

To properly ground the router, you need a 4-AWG grounding cable that is long enough to connect from the grounding points to earth ground, a grounding lug with two holes that fit over the grounding points, and two 1/4-20 UNC bolts to attach the lug to the grounding points. The grounding cable must be able to handle up to 90 A.

For specifications for the grounding cables, see "Power and Grounding Cable Specifications" on page 61.

For a description of connecting the router to earth ground, see "Disconnect and Connect DC Power" on page 165.

Network Cable Requirements

Table 17 lists specifications for each type of network cable used by the router. You must supply all the cables listed unless the table indicates that the cable is shipped with the system.

Table 17: Network Cable Specifications

Cable Type	Cable Specification	Supplied	Maximum Length	Connector Specification
DS-3 interface	75-ohm coaxial	One 10-ft (3.05-m) length	450 ft (137 m)	Mini BNC
E1 interface	75-ohm coaxial	One 10-ft (3.05-m) length	450 ft (137 m)	Mini BNC
	120/100-ohm balanced	No	655 ft (200 m)	RJ-48
E3 interface	75-ohm coaxial	One 10-ft (3.05-m) length	450 ft (137 m)	Mini BNC
T1 interface	120/100-ohm balanced	No	655 ft (200 m))	RJ-48
Single-mode interface (fiber)	SC-SC duplex	No	Short reach: 1.25 mi. (2 km)	SC
			Intermediate reach: 9.3 mi. (15 km)	SC
Multimode interface (fiber)	SC-SC duplex	No	1.25 mi. (2 km)	SC
Routing Engine console and auxiliary interface	RS-232 serial	One 6-foot length with DB-9/DB-9 connectors	6 ft. (1.83 m)	DB-9 female
Routing Engine Ethernet interface	Category 5 cable or equivalent suitable for 100BaseT operation	One 15-foot length with RJ-45/RJ-45 connectors	328 ft. (100 m)	RJ-45

Site Wiring Guidelines

You should consider the following factors when planning the wiring and cabling at your site:

- Distance Limitations for Signaling
- Radio Frequency Interference
- Electromagnetic Interference

Distance Limitations for Signaling

If wires are installed improperly, they can emit radio interference. In addition, potential damage from lightning strikes increases if wires exceed recommended distances, or if wires pass between buildings. The electromagnetic pulse (EMP) caused by lightning can damage unshielded conductors and destroy electronic devices. If your site has previously experienced such problems, you might want to consult experts in electrical surge suppression and shielding.

Radio Frequency Interference

If in your plant wiring you use twisted-pair cable with a good distribution of grounding conductors, the site wiring is unlikely to emit radio frequency interference (RFI). If you exceed the recommended distances, use a high-quality twisted-pair cable with one ground conductor for each data signal when applicable.

Electromagnetic Interference

If your site is susceptible to strong electromagnetic interference (EMI), particularly from lightning or radio transmitters, you might want to seek expert advice. Strong EMI could destroy the signal drivers and receivers in the router and could conduct power surges over the lines into the equipment, resulting in an electrical hazard.

It is particularly important to provide a properly grounded and shielded environment and to use electrical surge-suppression devices.

Fiber-Optic Connection Guidelines

The router accommodates two types of fiber-optic cable, which are used in both SONET/SDH and ATM PIC interfaces:

- Multimode Fiber
- Single-Mode Fiber

This section also discusses the following topics related to connecting fiber-optic cable:

- Attenuation and Dispersion
- Power Budget and Power Margin
- Connecting OC-192 and OC-48 PICs on page 70

Multimode Fiber

Multimode fiber is large enough in diameter to allow rays of light to internally reflect or bounce off the walls of the fiber. Light sources on interfaces with multimode optics are typically LEDs, which are not coherent light sources. An LED sprays varying wavelengths of light into multimode fiber, which reflects the light at different angles. Light rays travel in jagged lines through a multimode fiber, causing signal dispersion. When light traveling in the fiber core radiates into the fiber cladding, higher-order mode loss (HOL) results. All these factors limit the transmission distance of multimode fiber compared to single-mode fiber (see Table 18).

Single-Mode Fiber

Single-mode fiber is so small in diameter that there is not enough room for the rays of light passing through it to reflect internally through more than one layer. Light sources on interfaces with single-mode optics are lasers, which generate rays of light in a single wavelength and which travel in a straight line, directly through the single-mode fiber. Single-mode transmission is useful for longer distances and is capable of higher bandwidth than multimode fiber. However, it is also more expensive.

Table 18 lists the maximum distances for single-mode and multimode transmissions, as defined by SONET/SDH. Significant signal loss, causing unreliable transmission, can result if these distances are exceeded.

Table 18: Maximum Transmission Distances for Fiber-Optic Cable Types

Fiber-Optic Cable Type	Approximate Maximum Transmission Distance
Multimode	Up to 1.5 mi. (2.0 km)
Single-mode	Up to 9 mi. (14.8 km)

The router uses optical lasers for OC-3, OC-12, OC-48, and OC-192 SONET/SDH PIC single-mode interfaces. These optics are compliant with IR-1 of Bellcore GR-253-CORE Issue 2, December 1995 and ANSI TI.105.06. OC-192 optics are compliance with the Telecordia GR-1377 standard.

Table 19 lists the wavelength range supported by single-mode and multimode PIC interfaces.

Table 19: Wavelength Ranges Supported by Fiber-Optic Cable Types

Fiber-Optic Cable Type	Wavelength Range Supported
ATM	
STM-4/OC-12 ATM SMF-IR	1293–1334 nm
STM-4/OC-12 ATM MMF	1261–1360 nm
SONET / SDH	
STM-4/OC-12 SONET SMF-IR	1293 –1334 nm
STM-4/OC-12 SONET MMF	1261–1360 nm
STM-16/OC-48 SONET SMF-IR	1260–1360 nm
STM-64/OC-192 SONET SMF-SR-2	1530-1565 nm

Attenuation and Dispersion

Proper operation of an optical data link depends on modulated light reaching the receiver with enough power to be correctly demodulated. Attenuation is the reduction of the power of the light signal as it is transmitted. Attenuation is caused by passive media components, such as cables, cable splices, and connectors. While attenuation is significantly lower for optical fiber than for other media, it still occurs in both multimode and single-mode transmission. An efficient optical data link must have enough light available to overcome attenuation.

Dispersion is the spreading of the signal in time. For single-mode transmission, dispersion is negligible. For multimode transmission, however, the following two types of dispersion reduce the available power of the system by the combined dispersion penalty (in decibels [dB]):

- Chromatic dispersion—Measures the spread of the signal in time resulting from the different speeds of light rays
- Modal dispersion—Measures the spread of the signal in time resulting from the different propagation modes in the fiber

An efficient optical data link must have enough light available to exceed the minimum power that the receiver requires to operate within its specifications. The power lost over the optical data link is the sum of the component attenuation, chromatic dispersion, and modal dispersion losses.

Power Budget and Power Margin

The power budget (P_B) for a link is the maximum possible amount of power it can transmit. When you calculate the power budget, you use a worst-case analysis to provide a margin of error, although all the parts of an actual system do not operate at the worst-case levels. To calculate the worst-case estimate of power budget (P_B), you assume minimum transmitter power (P_T) and minimum receiver sensitivity (P_R).

Table 20 lists equations for calculating the power budget for SONET/SDH PIC interfaces. The values are measured in decibels (dB) and decibels referred to one milliwatt (dBm).

Table 20: Calculating Power Budget for SONET / SDH PIC Interfaces

PIC Interface	Power Budget Equation
Multimode	PB = PT – PR PB = –15 dBm – (–28 dBm) PB = 13 dB
OC-12 single-mode	PB = PT – PR PB = –15 dBm – (–28 dBm) PB = 13 dB
OC-48 single-mode	PB = PT – PR PB = –5 dBm – (–18 dBm) PB = 13 dB

After calculating the power budget for a link, you can calculate the power margin (P_M), which estimates the amount of power available for the link after subtracting attenuation or link loss (LL) from the power budget. A worst-case estimate of P_M assumes maximum LL:

PM = PB – LL

A P_M greater than zero indicates that the power budget is sufficient to operate the receiver.

Table 21 lists the factors that contribute to link loss and estimates the link-loss value attributable to those factors.

Table 21: Estimating Link Loss

Link-Loss Factor	Estimate of Link-Loss Value
Higher-order mode losses	Single-mode—None Multimode—0.5 dB
Modal and chromatic dispersion	Single-mode—None Multimode—Product of bandwidth and distance must be less than 500 MHz–km
Connector	0.5 dB
Splice	0.5 dB
Fiber attenuation	Single-mode—0.5 dB/km Multimode—1 dB/km

Power Margin Examples

The following example calculates a multimode power margin using the following variables:

- Length of multimode link—2 km
- Number of connectors—5
- Number of splices—2
- Higher-order loss
- Clock recovery module

Calculate the power margin as follows:

$P_M = P_B - LL$
$P_M = 13\text{ dB} - 2\text{ km }(1.0\text{ dB/km}) - 5\ (0.5\text{ dB}) - 2\ (0.5\text{ dB}) - 0.5\text{ dB (HOL)} - 1\text{ dB (CRM)}$
$PM = 13\text{ dB} - 2\text{ dB} - 2.5\text{ dB} - 1\text{ dB} - 0.5\text{ dB} - 1\text{ dB}$
$P_M = 6\text{ dB}$

The following example calculates the single-mode fiber power budget for two sites that are 8 km apart, connected with single-mode SONET/SDH cable with seven connectors.

- Length of single-mode link—8 km
- Number of connectors—7

Calculate the power margin as follows:

$P_M = P_B - LL$
$P_M = 13\text{ dB} - 8\text{ km }(0.5\text{ dB/km}) - 7\ (0.5\text{ dB})$
$P_M = 13\text{ dB} - 4\text{ dB} - 3.5\text{ dB}$
$P_M = 5.5\text{ dB}$

The calculated value of 5.5 dB indicates that this link has sufficient power for transmission and does not exceed the maximum receiver input power.

Connecting OC-192 and OC-48 PICs

The following information applies to the SONET/SDH OC-192 and OC-48 PICs.

Cleaning Connectors

Keep fiber-optic cable connections clean using an appropriate fiber-cleaning device, such as RIFOCS 945/946 Fiber Optic Connector Cleaning System.

OC-192 PIC Receiver Sensitivity

For the M160 router, there are two versions of OC-192 PIC. The two versions are identical except for differences in the sensitivity of the receiver optics. These differences require different amounts of attenuation.

If the OC-192 PIC has the part number 750-002073, the amount of attenuation typically required when going back-to-back to another OC-192 PIC is 15 db on the receiver. The receiver sensitivity of this is between -13db and -22db.

If the OC-192 PIC has the part number 750-003184, the amount of attenuation typically required when going back-to-back to another OC-192 PIC is 5 db on the receiver. The receiver sensitivity of this is between -3 db and -14 db.

To determine the part number of the OC-192 PIC, use the following CLI command:

```
user@host> show chassis hardware
```

Interoperability for OC-192 Interface

The SONET/SDH OC-192 interface is an SR-2 interface, with a transmit wavelength of 1550 nm. Some OC-192 interfaces from other vendors are SR-1 interfaces which have a transmit wavelength of 1310 nm. The OC-192 interface can receive at both 1310 nm and 1550 nm.

To ensure interoperability with other vendors’ SR-1 and SR-2 interfaces, follow these guidelines:

- Be sure the power levels of the send and receive interfaces are matched by checking that the actual power at the receiver is within the range of acceptable power levels.
- When connecting SR-2 and SR-1 interfaces, allow an extra 1 dB of margin in the power budget to account for minor variations in receiver sensitivity at different wavelengths.

Interoperability for OC-48 PIC

The OC-48 PIC is an SR interface, unlike the OC-48 interface used in M40 and M20 routers, which is an IR-1 interface. These two interfaces have different input and output power levels, as shown in Table 22.

Table 22: M160 and M40 / M20 OC-48 PIC Power Specifications

Interface	Max. input (dBm)	Min. input (dBm)	Max. output (dBm)	Min. output (dBm)
SR (M160 router)	–3	–18	–3	–10
IR-1 (M20 and M40 routers)	0	–18	0	–5

The IR-1 interface may transmit more power than the SR-1 PIC can receive without experiencing saturation. To prevent saturation from occurring, you might need to attenuate power at the SR-1 receiver. The IR-1 receiver should not require attenuation, since the SR-1 transmit levels do not exceed the IR-1's receive levels.

To determine the amount of attenuation needed, measure the power level at each receiver. Attenuate the power to bring it within the allowable range; for short lengths of fiber, with fiber and connector loss close to zero, an attenuator of 5-10 dB should be sufficient.

End-to-end and loopback connections for OC-192 Interface

The receiver of an OC-192 interface has very high sensitivity and low minimum and maximum allowable power. A direct fiber connection from transmitter to receiver, whether end-to-end or loopback, can easily overload the receiver. To prevent the receiver from overloading, you need to attenuate the receiving end.

When connecting two OC-192 interfaces, follow these guidelines:

- Determine the minimum and maximum for both the transmit power and the allowable receive power.
- Measure the transmitted power at the receiver to account for all connector and fiber cable losses.
- Add attenuation before the receiver to bring the power levels within allowable range.

For example, if you are connecting two OC-192 interfaces in the same room, you would use a short length of fiber, and the connector and fiber cable loss would be close to zero. In this situation, a 15 dB attenuator before the receiver should be sufficient to bring the receiver within the allowable range.

Site Preparation Checklist

To help prepare your site for installing an router, use the checklist in Table 23.

Table 23: Site Preparation Checklist

Item or Task	Prepared By	Date	Notes
Assess temperature, humidity, altitude, and other environmental requirements.			
Locate power sources, and measure the distance to system installation site.			
Select the type of rack to be used.			
Measure space for the rack, including specified maintenance clearances.			
Acquire specified cables and connectors.			
Locate sites for connection of system grounding.			
Secure rack to the floor and building structure.			
Assess the power budget and power margin for your site.			

Chapter 6
Regulatory Compliance and Safety Information

To safely install and use the router, you must understand the safety warnings and follow proper safety guidelines. This chapter provides regulatory compliance and safety information for the router:

- Safety Guidelines and Warnings on page 73
- Agency Approvals on page 106
- Compliance Statements for EMC Requirements on page 108

Safety Guidelines and Warnings

This section provides the safety guidelines and warnings for installing, operating, and maintaining the router:

- General Safety Guidelines on page 73
- Electricity Safety Guidelines and Warnings on page 77
- Installation Guidelines and Warnings on page 91
- Laser and LED Safety Guidelines and Warnings on page 97
- Operation and Maintenance Safety Guidelines and Warnings on page 101

General Safety Guidelines

The following guidelines help ensure your safety and protect the router. The list of guidelines might not address all potentially hazardous situations in your working environment, so be alert, and exercise good judgement at all times.

Warning	Only trained service personnel should install the equipment.

Warning

Read the installation instructions before you connect the equipment to its power source.

- Perform only those system services that are explicitly described in this installation guide. Make sure that only authorized service personnel perform other system services.
- Keep the chassis area clear and free from dust before, during, and after installation.
- Keep tools away from areas where people could trip over them while walking.
- Do not wear loose clothing or jewelry, such as rings, bracelets, or chains, which could become caught in the chassis.
- Wear safety glasses if you are working under any conditions that could be hazardous to your eyes.
- Do not perform any actions that create a potential hazard to people or make the equipment unsafe.
- Never attempt to lift an object that is too heavy for one person to handle.
- Never install wiring during electrical storms.
- Never install electrical jacks in wet locations unless the jacks are specifically designed for wet environments.
- Operate the router only when the grounding wire is connected.
- Replace fuses only with fuses of the same type and rating.
- Do not open or remove chassis covers or sheet metal parts when instructions are not provided in this manual. Such an action could cause severe electrical shock.
- Do not push or force any objects through any of the openings in the chassis frame. Such an action could result in electrical shock or fire.
- Avoid spilling liquid onto the router chassis or onto any router component. Such an action could cause electrical shock or damage the router.
- Avoid touching uninsulated electrical wires or terminals that have not been disconnected from their power source. Such an action could cause electrical shock.

Qualified Personnel Warning

Warning

Only trained and qualified personnel should install or replace the router.

Waarschuwing Installatie en reparaties mogen uitsluitend door getraind en bevoegd personeel uitgevoerd worden.

Varoitus Ainoastaan koulutettu ja pätevä henkilökunta saa asentaa tai vaihtaa tämän laitteen.

Avertissement Tout installation ou remplacement de l'appareil doit être réalisé par du personnel qualifié et compétent.

Achtung Gerät nur von geschultem, qualifiziertem Personal installieren oder auswechseln lassen.

Avvertenza Solo personale addestrato e qualificato deve essere autorizzato ad installare o sostituire questo apparecchio.

Advarsel Kun kvalifisert personell med riktig opplæring bør montere eller bytte ut dette utstyret.

Aviso Este equipamento deverá ser instalado ou substituído apenas por pessoal devidamente treinado e qualificado.

¡Atención! Estos equipos deben ser instalados y reemplazados exclusivamente por personal técnico adecuadamente preparado y capacitado.

Varning Denna utrustning ska endast installeras och bytas ut av utbildad och kvalificerad personal.

Restricted Access Area Warning

Warning

The router is intended for installation in restricted access areas. A restricted access area is an area to which access can be gained only by service personnel through the use of a special tool, lock and key, or other means of security, and that is controlled by the authority responsible for the location.

Waarschuwing   Dit toestel is bedoeld voor installatie op plaatsen met beperkte toegang. Een plaats met beperkte toegang is een plaats waar toegang slechts door servicepersoneel verkregen kan worden door middel van een speciaal instrument, een slot en sleutel, of een ander veiligheidsmiddel, en welke beheerd wordt door de overheidsinstantie die verantwoordelijk is voor de locatie.

Varoitus   Tämä laite on tarkoitettu asennettavaksi paikkaan, johon pääsy on rajoitettua. Paikka, johon pääsy on rajoitettua, tarkoittaa paikkaa, johon vain huoltohenkilöstö pääsee jonkin erikoistyökalun, lukkoon sopivan avaimen tai jonkin muun turvalaitteen avulla ja joka on paikasta vastuussa olevien toimivaltaisten henkilöiden valvoma.

Attention   Cet appareil est à installer dans des zones d'accès réservé. Ces dernières sont des zones auxquelles seul le personnel de service peut accéder en utilisant un outil spécial, un mécanisme de verrouillage et une clé, ou tout autre moyen de sécurité. L'accès aux zones de sécurité est sous le contrôle de l'autorité responsable de l'emplacement.

Warnung   Diese Einheit ist zur Installation in Bereichen mit beschränktem Zutritt vorgesehen. Ein Bereich mit beschränktem Zutritt ist ein Bereich, zu dem nur Wartungspersonal mit einem Spezialwerkzeugs, Schloß und Schlüssel oder anderer Sicherheitsvorkehrungen Zugang hat, und der von dem für die Anlage zuständigen Gremium kontrolliert wird.

Avvertenza   Questa unità deve essere installata in un'area ad accesso limitato. Un'area ad accesso limitato è un'area accessibile solo a personale di assistenza tramite un'attrezzo speciale, lucchetto, o altri dispositivi di sicurezza, ed è controllata dall'autorità responsabile della zona.

Advarsel   Denne enheten er laget for installasjon i områder med begrenset adgang. Et område med begrenset adgang gir kun adgang til servicepersonale som bruker et spesielt verktøy, lås og nøkkel, eller en annen sikkerhetsanordning, og det kontrolleres av den autoriteten som er ansvarlig for området.

Aviso   Esta unidade foi concebida para instalação em áreas de acesso restrito. Uma área de acesso restrito é uma área à qual apenas tem acesso o pessoal de serviço autorizado, que possua uma ferramenta, chave e fechadura especial, ou qualquer outra forma de segurança. Esta área é controlada pela autoridade responsável pelo local.

¡Advertencia!   Esta unidad ha sido diseñada para instalarse en áreas de acceso restringido. Área de acceso restringido significa un área a la que solamente tiene acceso el personal de servicio mediante la utilización de una herramienta especial, cerradura con llave, o algún otro medio de seguridad, y que está bajo el control de la autoridad responsable del local.

Varning!   Denna enhet är avsedd för installation i områden med begränsat tillträde. Ett område med begränsat tillträde får endast tillträdas av servicepersonal med ett speciellt verktyg, lås och nyckel, eller annan säkerhetsanordning, och kontrolleras av den auktoritet som ansvarar för området.

Electricity Safety Guidelines and Warnings

When working on equipment powered by electricity, follow these guidelines:

General Electrical Safety Guidelines

Warning

Disconnect the DC power to the router at the circuit breakers.

- Locate the emergency power-off switch for the room in which you are working so that if an electrical accident occurs, you can quickly turn off the power.
- Do not work alone if potentially hazardous conditions exist anywhere in your workspace.
- Never assume that power is disconnected from a circuit. Always check the circuit before starting to work.
- Carefully look for possible hazards in your work area, such as moist floors, ungrounded power extension cords, and missing safety grounds.
- Operate the router within marked electrical ratings and product usage instructions.

- Install the router with the following local, national, or international electrical codes:
  - United States—National Fire Protection Association (NFPA70), United States National Electrical Code.
  - Canada—Canadian Electrical Code, Part 1, CSA C22.1.
  - Other countries—International Electromechanical Commission (IEC) 364, Part 1 through Part 7.
  - Evaluated to the TN and IT power systems.

The SFMs, Routing Engines, MCS, PCGs FPCs, PICs, power supplies, and cooling system components can be removed and replaced without powering down or disconnecting power to the router. Observe the following guidelines for maintaining electrical safety:

- Never install equipment if it appears damaged.
- Periodically inspect the installation site for potential hazards such as wet floors and for ungrounded power extension cords.

Copper Conductors Warning

Use copper conductors only.

Waarschuwing   Gebruik alleen koperen geleiders.

Varoitus   Käytä vain kuparijohtimia.

Attention   Utilisez uniquement des conducteurs en cuivre.

Warnung   Verwenden Sie ausschließlich Kupferleiter.

Avvertenza   Usate unicamente dei conduttori di rame.

Advarsel   Bruk bare kobberledninger.

Aviso   Utilize apenas fios condutores de cobre.

¡Advertencia!   Emplee sólo conductores de cobre.

Varning!   Använd endast ledare av koppar.

DC-Power Guidelines

When working with DC-powered routers, follow these guidelines:

- DC-powered routers are equipped with a DC terminal block. You must terminate the DC input wiring on a DC source capable of supplying at least 65 A. A 90 A circuit breaker is required at the 48 VDC facility power source. An easily accessible disconnect device should be incorporated into the facility wiring. Be sure to connect the grounding wire conduit to a solid earth ground. A closed loop ring is recommended to terminate the ground conductor at the ground stud.

- Run two wires from the router's on-board circuit breaker box to a source of 48 VDC. Use appropriate gauge wire to handle up to 90 A.

- You must connect only a DC power source that complies with the safety extra low-voltage (SELV) requirements of UL 1950, CSA C22.2 No. 950-95, EN 60950 and IEC 60950 to a DC-input terminal block.

- A DC-powered router that is equipped with a DC terminal block is intended only for installation in a restricted access location. In the United States, a restricted access area is one in accordance with Articles 110-16, 110-17, and 110-18 of the National Electrical Code ANSI/NFPA 70.

- The marked input voltage of –48 VDC for DC-powered routers is the nominal voltage associated with the battery circuit, and any higher voltages are only to be associated with float voltages for the charging function.

- Ensure that the polarity of the DC input wiring is correct. Under certain conditions, connections with reversed polarity might trip the primary circuit breaker or damage the equipment.

- Because the router is a positive ground system, you must connect the positive lead to the +RTN terminal, the negative lead to the –48V terminal, and the earth ground to the chassis grounding points. Use a hexagonal-head external drive socket wrench, with a minimum of 30 lb.-ins. (3.5 Nm) tightening torque, to connect the leads to the terminals.
- For personal safety, connect the green and yellow wire to safety (earth) ground at both the router and the supply side of the DC wiring.
- Terminate the DC input wiring on a DC source capable of supplying at least 70 A. Incorporate an easily accessible disconnect device into the facility wiring. Be sure to connect the ground wire or conduit to a solid office (earth) ground.

> **Note**
>
> Primary overcurrent protection is provided by the building circuit breaker. This breaker should protect against excess currents, short circuits, and earth faults in accordance with NEC ANSI/NFPA70.

DC Power Supply Warning

Warning

When stranded wiring is required, use approved wiring terminations, such as closed-loop or spade-type with upturned lugs. These terminations should be the appropriate size for the wires and should clamp both the insulation and conductor.

Waarschuwing Wanneer geslagen bedrading vereist is, dient u bedrading te gebruiken die voorzien is van goedgekeurde aansluitingspunten, zoals het gesloten-lus type of het grijperschop type waarbij de aansluitpunten omhoog wijzen. Deze aansluitpunten dienen de juiste maat voor de draden te hebben en dienen zowel de isolatie als de geleider vast te klemmen.

Varoitus Jos säikeellinen johdin on tarpeen, käytä hyväksyttyä johdinliitäntää, esimerkiksi suljettua silmukkaa tai kourumaista liitäntää, jossa on ylöspäin käännetyt kiinnityskorvat. Tällaisten liitäntöjen tulee olla kooltaan johtimiin sopivia ja niiden tulee puristaa yhteen sekä eristeen että johdinosan.

Attention Quand des fils torsadés sont nécessaires, utiliser des douilles terminales homologuées telles que celles à circuit fermé ou du type à plage ouverte avec cosses rebroussées. Ces douilles terminales doivent être de la taille qui convient aux fils et doivent être refermées sur la gaine isolante et sur le conducteur.

Warnung Wenn Litzenverdrahtung erforderlich ist, sind zugelassene Verdrahtungsabschlüsse, z.B. für einen geschlossenen Regelkreis oder gabelförmig, mit nach oben gerichteten Kabelschuhen zu verwenden. Diese Abschlüsse sollten die angemessene Größe für die Drähte haben und sowohl die Isolierung als auch den Leiter festklemmen.

Avvertenza Quando occorre usare trecce, usare connettori omologati, come quelli a occhiello o a forcella con linguette rivolte verso l'alto. I connettori devono avere la misura adatta per il cablaggio e devono serrare sia l'isolante che il conduttore.

Advarsel Hvis det er nødvendig med flertrådede ledninger, brukes godkjente ledningsavslutninger, som for eksempel lukket sløyfe eller spadetype med oppoverbøyde kabelsko. Disse avslutningene skal ha riktig størrelse i forhold til ledningene, og skal klemme sammen både isolasjonen og lederen.

Aviso Quando forem requeridas montagens de instalação eléctrica de cabo torcido, use terminações de cabo aprovadas, tais como, terminações de cabo em circuito fechado e planas com terminais de orelha voltados para cima. Estas terminações de cabo deverão ser do tamanho apropriado para os respectivos cabos, e deverão prender simultaneamente o isolamento e o fio condutor.

¡Advertencia! Cuando se necesite hilo trenzado, utilizar terminales para cables homologados, tales como las de tipo "bucle cerrado" o "espada", con las lengüetas de conexión vueltas hacia arriba. Estos terminales deberán ser del tamaño apropiado para los cables que se utilicen, y tendrán que sujetar tanto el aislante como el conductor.

Varning! När flertrådiga ledningar krävs måste godkända ledningskontakter användas, t.ex. kabelsko av sluten eller öppen typ med uppåtvänd tapp. Storleken på dessa kontakter måste vara avpassad till ledningarna och måste kunna hålla både isoleringen och ledaren fastklämda.

DC Power Disconnection Warning

Warning

Before performing any of the following procedures, ensure that power is removed from the DC circuit. To ensure that all power is off, locate the circuit breaker on the panel board that services the DC circuit, switch the circuit breaker to the OFF position, and tape the switch handle of the circuit breaker in the OFF position.

Waarschuwing   Voordat u een van de onderstaande procedures uitvoert, dient u te controleren of de stroom naar het gelijkstroom circuit uitgeschakeld is. Om u ervan te verzekeren dat alle stroom UIT is geschakeld, kiest u op het schakelbord de stroomverbreker die het gelijkstroom circuit bedient, draait de stroomverbreker naar de UIT positie en plakt de schakelaarhendel van de stroomverbreker met plakband in de UIT positie vast.

Varoitus   Varmista, että tasavirtapiirissä ei ole virtaa ennen seuraavien toimenpiteiden suorittamista. Varmistaaksesi, että virta on KATKAISTU täysin, paikanna tasavirrasta huolehtivassa kojetaulussa sijaitseva suojakytkin, käännä suojakytkin KATKAISTU-asentoon ja teippaa suojakytkimen varsi niin, että se pysyy KATKAISTU-asennossa.

Attention   Avant de pratiquer l'une quelconque des procédures ci-dessous, vérifier que le circuit en courant continu n'est plus sous tension. Pour en être sûr, localiser le disjoncteur situé sur le panneau de service du circuit en courant continu, placer le disjoncteur en position fermée (OFF) et, à l'aide d'un ruban adhésif, bloquer la poignée du disjoncteur en position OFF.

Warnung   Vor Ausführung der folgenden Vorgänge ist sicherzustellen, daß die Gleichstromschaltung keinen Strom erhält. Um sicherzustellen, daß sämtlicher Strom abgestellt ist, machen Sie auf der Schalttafel den Unterbrecher für die Gleichstromschaltung ausfindig, stellen Sie den Unterbrecher auf AUS, und kleben Sie den Schaltergriff des Unterbrechers mit Klebeband in der AUS-Stellung fest.

Avvertenza   Prima di svolgere una qualsiasi delle procedure seguenti, verificare che il circuito CC non sia alimentato. Per verificare che tutta l'alimentazione sia scollegata (OFF), individuare l'interruttore automatico sul quadro strumenti che alimenta il circuito CC, mettere l'interruttore in posizione OFF e fissarlo con nastro adesivo in tale posizione.

Warning

Advarsel Før noen av disse prosedyrene utføres, kontroller at strømmen er frakoblet likestrømkretsen. Sørg for at all strøm er slått AV. Dette gjøres ved å lokalisere strømbryteren på brytertavlen som betjener likestrømkretsen, slå strømbryteren AV og teipe bryterhåndtaket på strømbryteren i AV-stilling.

Aviso Antes de executar um dos seguintes procedimentos, certifique-se que desligou a fonte de alimentação de energia do circuito de corrente contínua. Para se assegurar que toda a corrente foi DESLIGADA, localize o disjuntor no painel que serve o circuito de corrente contínua e coloque-o na posição OFF (Desligado), segurando nessa posição a manivela do interruptor do disjuntor com fita isoladora.

¡Advertencia! Antes de proceder con los siguientes pasos, comprobar que la alimentación del circuito de corriente continua (CC) esté cortada (OFF). Para asegurarse de que toda la alimentación esté cortada (OFF), localizar el interruptor automático en el panel que alimenta al circuito de corriente continua, cambiar el interruptor automático a la posición de Apagado (OFF), y sujetar con cinta la palanca del interruptor automático en posición de Apagado (OFF).

Varning! Innan du utför någon av följande procedurer måste du kontrollera att strömförsörjningen till likströmskretsen är bruten. Kontrollera att all strömförsörjning är BRUTEN genom att slå AV det överspänningsskydd som skyddar likströmskretsen och tejpa fast överspänningsskyddets omkopplare i FRÅN-läget.

DC Power Supply Wiring Warning

Warning

Wire the DC power supply using the appropriate lugs. When connecting power, the proper wiring sequence is ground to ground, +RTN to +RTN, then -48 V to -48 V. When disconnecting power, the proper wiring sequence is -48 V to -48 V, +RTN to +RTN, then ground to ground. Note that the ground wire should always be connected first and disconnected last.

Waarschuwing De juiste bedradingsvolgorde verbonden is aarde naar aarde, +RTN naar +RTN, en –48 V naar – 48 V. De juiste bedradingsvolgorde losgemaakt is en –48 V naar – 48 V, +RTN naar +RTN, aarde naar aarde.

Varoitus Oikea yhdistettava kytkentajarjestys on maajohto maajohtoon, +RTN varten +RTN, –48 V varten – 48 V. Oikea irrotettava kytkentajarjestys on –48 V varten – 48 V, +RTN varten +RTN, maajohto maajohtoon.

Attention Câblez l'approvisionnement d'alimentation CC En utilisant les crochets appropriés à l'extrémité de câblage. En reliant la puissance, l'ordre approprié de câblage est rectifié pour rectifier, +RTN à +RTN, puis -48 V à -48 V. En débranchant la puissance, l'ordre approprié de câblage est -48 V à -48 V, +RTN à +RTN, a alors rectifié pour rectifier. Notez que le fil de masse devrait toujours être relié d'abord et débranché pour la dernière fois. Notez que le fil de masse devrait toujours être relié d'abord et débranché pour la dernière fois.

Warnung Verdrahten Sie die Gleichstrom-Versorgung mit den passenden Ansätzen am Verdrahtung Ende. Wenn man Energie anschließt, wird die korrekte Verdrahtung. Reihenfolge gerieben, um, +RTN zu +RTN, dann -48 V bis -48 V zu reiben. Wenn sie Energie trennt, ist die korrekte Verdrahtung Reihenfolge -48 V bis -48 V, +RTN zu +RTN, rieb dann, um zu reiben. Beachten Sie, daß der Erdungsdraht immer zuerst angeschlossen werden und zuletzt getrennt werden sollte. Beachten Sie, daß der Erdungsdraht immer zuerst angeschlossen werden und zuletzt getrennt werden sollte.

Avvertenza Mostra la morsettiera dell alimentatore CC. Cablare l'alimentatore CC usando i connettori adatti all'estremità del cablaggio, come illustrato. La corretta sequenza di cablaggio è da massa a massa, da positivo a positivo (da linea ad L) e da negativo a negativo (da neutro a N). Tenere presente che il filo di massa deve sempre venire collegato per primo e scollegato per ultimo.

Warning

Advarsel Riktig tilkoples tilkoplingssekvens er jord til jord, + RTN til + RTN, –48 V til – 48 V. Riktig frakoples tilkoplingssekvens er –48 V til – 48 V, + RTN til + RTN, jord til jord.

Aviso Ate con alambre la fuente de potencia cc Usando los terminales apropiados en el extremo del cableado. Al conectar potencia, la secuencia apropiada del cableado se muele para moler, + RTN a + RTN, entonces -48 V a -48 V. Al desconectar potencia, la secuencia apropiada del cableado es -48 V a -48 V, + RTN a + RTN, entonces molió para moler. Observe que el alambre de tierra se debe conectar siempre primero y desconectar por último. Observe que el alambre de tierra se debe conectar siempre primero y desconectar por último.

¡Advertencia! Wire a fonte de alimentação de DC Usando os talões apropriados na extremidade da fiação. Ao conectar a potência, a seqüência apropriada da fiação é moída para moer, + RTN a + RTN, então -48 V a -48 V. Ao desconectar a potência, a seqüência apropriada da fiação é -48 V a -48 V, + RTN a + RTN, moeu então para moer. Anote que o fio à terra deve sempre ser conectado primeiramente e desconectado por último. Anote que o fio à terra deve sempre ser conectado primeiramente e desconectado por último.

Varning! Korrekt kopplingssekvens ar jord till jord, + RTN till + RTN, –48 V till – 48 V. Korrekt kopplas kopplingssekvens ar –48 V till – 48 V, + RTN till + RTN, jord till jord.

Ground Connection Warning

When installing the router, the ground connection must always be made first and disconnected last.

Waarschuwing Bij de installatie van het toestel moet de aardverbinding altijd het eerste worden gemaakt en het laatste worden losgemaakt.

Varoitus Laitetta asennettaessa on maahan yhdistäminen aina tehtävä ensiksi ja maadoituksen irti kytkeminen viimeiseksi.

Attention Lors de l'installation de l'appareil, la mise à la terre doit toujours être connectée en premier et déconnectée en dernier.

Warnung Der Erdanschluß muß bei der Installation der Einheit immer zuerst hergestellt und zuletzt abgetrennt werden.

Avvertenza In fase di installazione dell'unità, eseguire sempre per primo il collegamento a massa e disconnetterlo per ultimo.

Advarsel Når enheten installeres, må jordledningen alltid tilkobles først og frakobles sist.

Aviso Ao instalar a unidade, a ligação à terra deverá ser sempre a primeira a ser ligada, e a última a ser desligada.

¡Advertencia! Al instalar el equipo, conectar la tierra la primera y desconectarla la última.

Varning! Vid installation av enheten måste jordledningen alltid anslutas först och kopplas bort sist.

Grounded Equipment Warning

Warning

The router is intended to be grounded. Ensure that the router is connected to earth ground during normal use.

Waarschuwing   Deze apparatuur hoort geaard te worden Zorg dat de host-computer tijdens normaal gebruik met aarde is verbonden.

Varoitus   Tämä laitteisto on tarkoitettu maadoitettavaksi. Varmista, että isäntälaite on yhdistetty maahan normaalikäytön aikana.

Attention   Cet équipement doit être relié à la terre. S'assurer que l'appareil hôte est relié à la terre lors de l'utilisation normale.

Warnung   Dieses Gerät muß geerdet werden. Stellen Sie sicher, daß das Host-Gerät während des normalen Betriebs an Erde gelegt ist.

Avvertenza   Questa apparecchiatura deve essere collegata a massa. Accertarsi che il dispositivo host sia collegato alla massa di terra durante il normale utilizzo.

Advarsel   Dette utstyret skal jordes. Forviss deg om vertsterminalen er jordet ved normalt bruk.

Aviso   Este equipamento deverá estar ligado à terra. Certifique-se que o host se encontra ligado à terra durante a sua utilização normal.

¡Advertencia!   Este equipo debe conectarse a tierra. Asegurarse de que el equipo principal esté conectado a tierra durante el uso normal.

Varning!   Denna utrustning är avsedd att jordas. Se till att värdenheten är jordad vid normal användning.

In Case of Electrical Accident

In the event of an electrical accident resulting in an injury, take the following actions in this order:

1. Use caution—Be aware of potentially hazardous conditions.

2. Disconnect power from the router.

3. If possible, send another person to get medical aid. Otherwise, assess the condition of the victim then call for help.

Power and Grounding Requirements

For the router and peripheral equipment to function safely and correctly, use the cables and connectors specified for the attached peripheral equipment, and make certain they are in good condition.

An insulated grounding conductor that is identical in size to the grounded and ungrounded branch circuit supply conductors, but is identifiable by green and yellow stripes, is installed as part of the branch circuit that supplies the unit. The grounding conductor is a separately derived system at the supply transformer or motor generator set.

Power Supply Disconnection Warning

Warning

Before working on the router or near power supplies, disconnect the DC power at the circuit breakers.

Waarschuwing   Voordat u aan een frame of in de nabijheid van voedingen werkt, dient u bij wisselstroom toestellen de stekker van het netsnoer uit het stopcontact te halen; voor gelijkstroom toestellen dient u de stroom uit te schakelen bij de stroomverbreker.

Varoitus   Kytke irti vaihtovirtalaitteiden virtajohto ja katkaise tasavirtalaitteiden virta suojakytkimellä, ennen kuin teet mitään asennuspohjalle tai työskentelet virtalähteiden läheisyydessä.

Attention   Avant de travailler sur un châssis ou à proximité d'une alimentation électrique, débrancher le cordon d'alimentation des unités en courant alternatif; couper l'alimentation des unités en courant continu au niveau du disjoncteur.

Warnung   Bevor Sie an einem Chassis oder in der Nähe von Netzgeräten arbeiten, ziehen Sie bei Wechselstromeinheiten das Netzkabel ab bzw. schalten Sie bei Gleichstromeinheiten den Strom am Unterbrecher ab.

Avvertenza   Prima di lavorare su un telaio o intorno ad alimentatori, scollegare il cavo di alimentazione sulle unità CA; scollegare l'alimentazione all'interruttore automatico sulle unità CC.

Advarsel   Før det utføres arbeid på kabinettet eller det arbeides i nærheten av str¿mforsyningsenheter, skal str¿mledningen trekkes ut p vekselstrømsenheter og strømmen kobles fra ved strømbryteren på likestrømsenheter.

Aviso   Antes de trabalhar num chassis, ou antes de trabalhar perto de unidades de fornecimento de energia, desligue o cabo de alimentação nas unidades de corrente alternada; desligue a corrente no disjuntor nas unidades de corrente contínua.

¡Advertencia!   Antes de manipular el chasis de un equipo o trabajar cerca de una fuente de alimentación, desenchufar el cable de alimentación en los equipos de corriente alterna (CA); cortar la alimentación desde el interruptor automático en los equipos de corriente continua (CC).

Varning!   Innan du arbetar med ett chassi eller nära strömförsörjningsenheter skall du för växelströmsenheter dra ur nätsladden och för likströmsenheter bryta strömmen vid överspänningsskyddet.

Power Supply Connection Warning

Warning

The router has more than one power supply connection. All connections must be removed completely to completely remove power from the unit.

Waarschuwing   Deze eenheid heeft meer dan één stroomtoevoerverbinding; alle verbindingen moeten volledig worden verwijderd om de stroom van deze eenheid volledig te verwijderen.

Varoitus   Tässä laitteessa on useampia virtalähdekytkentöjä. Kaikki kytkennät on irrotettava kokonaan, jotta virta poistettaisiin täysin laitteesta.

Attention   Cette unité est équipée de plusieurs raccordements d'alimentation. Pour supprimer tout courant électrique de l'unité, tous les cordons d'alimentation doivent être débranchés.

Warnung   Diese Einheit verfügt über mehr als einen Stromanschluß; um Strom gänzlich von der Einheit fernzuhalten, müssen alle Stromzufuhren abgetrennt sein.

Avvertenza   Questa unità ha più di una connessione per alimentatore elettrico; tutte le connessioni devono essere completamente rimosse per togliere l'elettricità dall'unità.

Advarsel   Denne enheten har mer enn én strømtilkobling. Alle tilkoblinger må kobles helt fra for å eliminere strøm fra enheten.

Aviso   Este dispositivo possui mais do que uma conexão de fonte de alimentação de energia; para poder remover a fonte de alimentação de energia, deverão ser desconectadas todas as conexões existentes.

¡Advertencia!   Esta unidad tiene más de una conexión de suministros de alimentación; para eliminar la alimentación por completo, deben desconectarse completamente todas las conexiones.

Varning!   Denna enhet har mer än en strömförsörjningsanslutning; alla anslutningar måste vara helt avlägsnade innan strömtillförseln till enheten är fullständigt bruten.

TN and IT Power Warning

Warning

The router is designed to work with TN, IT power systems.

Waarschuwing Het apparaat is ontworpen om te functioneren met TN, IT energiesystemen.

Varoitus Koje on suunniteltu toimimaan TN-, IT-sähkövoimajärjestelmien yhteydessä.

Attention Ce dispositif a été conçu pour fonctionner avec des systèmes d'alimentation TN.

Warnung Das Gerät ist für die Verwendung mit TN-, IT-Stromsystemen ausgelegt.

Avvertenza Il dispositivo è stato progettato per l'uso con sistemi di alimentazione TN, IT.

Advarsel Utstyret er utfomet til bruk med TN-, IT-strømsystemer.

Aviso O dispositivo foi criado para operar com sistemas de corrente TN, IT.

¡Advertencia! El equipo está diseñado para trabajar con sistemas de alimentación tipo TN, IT.

Varning! Enheten är konstruerad för användning tillsammans med elkraftssystem av TN-, IT-typ.

Installation Guidelines and Warnings

Observe the following guidelines and warnings before and during router installation:

- Chassis Lifting Guidelines and Warnings on page 91
- Installation Instructions Warning on page 92
- Rack-Mounting Requirements and Warnings on page 93
- Ramp Warning on page 97

Chassis Lifting Guidelines and Warnings

A fully configured router weighs about 370 lbs (168 kg). Observe the following guidelines for lifting and moving the system:

- Before moving the router, read the site preparation guidelines in “Prepare the Site” on page 53 to ensure that the intended site meets the specified power, environmental, and clearance requirements.
- Before lifting or moving the router, disconnect all external cables.

- Do not attempt to lift a fully configured router by yourself—The system is meant to be lifted using a mechanical lift. If lifted manually, it must be lifted by a minimum of three people, and the components must be removed before lifting (as described in “Install the Router and Its Components” on page 117).

- As when lifting any heavy object, lift most of the weight with your legs rather than your back—Keep your knees bent and your back relatively straight and avoid twisting as you lift. Balance the load evenly and be sure that your footing is solid.

Warning Three people at minimum are required to lift the chassis. Before lifting the chassis, remove components and attach the installation lifting handle as described in “Install the Router and Its Components” on page 117. To prevent injury, keep your back straight and lift with your legs, not your back. Do not attempt to lift the chassis with the handles on the power supplies.

Installation Instructions Warning

Warning Read the installation instructions before you connect the router to a power source.

Waarschuwing Raadpleeg de installatie-aanwijzingen voordat u het systeem met de voeding verbindt.

Varoitus Lue asennusohjeet ennen järjestelmän yhdistämistä virtalähteeseen.

Attention Avant de brancher le système sur la source d'alimentation, consulter les directives d'installation.

Warnung Lesen Sie die Installationsanweisungen, bevor Sie das System an die Stromquelle anschließen.

Avvertenza Consultare le istruzioni di installazione prima di collegare il sistema all'alimentatore.

Advarsel Les installasjonsinstruksjonene før systemet kobles til strømkilden.

Aviso Leia as instruções de instalação antes de ligar o sistema à sua fonte de energia.

¡Atención! Ver las instrucciones de instalación antes de conectar el sistema a la red de alimentación.

Varning! Läs installationsanvisningarna innan du kopplar systemet till dess strömförsörjningsenhet.

Rack-Mounting Requirements and Warnings

Make sure that rack-mounting the router does not create a hazardous condition because of uneven mechanical loading. Ensure that any equipment rack is evenly and securely supported.

Warning

The router must be installed into a rack that is secured to the building structure.

Waarschuwing De Juniper Networks M160 router moet in een stellage worden geïnstalleerd die aan een bouwsel is verankerd.

Varoitus Juniper Networks M160 router on asennettava telineeseen, joka on kiinnitetty rakennukseen.

Attention Le rack sur lequel est monté le Juniper Networks M160 router doit être fixé à la structure du bâtiment.

Warnung Der Juniper Networks M160 router muß in einem Gestell installiert werden, das in der Gebäudestruktur verankert ist.

Avvertenza Il Juniper Networks M160 router deve essere installato in un telaio, il quale deve essere fissato alla struttura dell'edificio.

Advarsel Juniper Networks M160 router må installeres i et stativ som er forankret til bygningsstrukturen.

Aviso O Juniper Networks M160 router deverá ser instalado numa prateleira fixa à estrutura do edificio.

¡Advertencia! El Juniper Networks M160 router debe instalarse en un bastidor fijado a la estructura del edificio.

Varning! Juniper Networks M160 router måste installeras i en ställning som är förankrad i byggnadens struktur.

Warning

To prevent bodily injury when mounting or servicing the router in a rack, take the following precautions to ensure that the system remains stable:

The router should be mounted at the bottom of the rack if it is the only unit in the rack.

When mounting the router in a partially filled rack, load the rack from the bottom to the top with the heaviest component at the bottom of the rack.

If the rack is provided with stabilizing devices, install the stabilizers before mounting or servicing the router in the rack.

Waarschuwing Om lichamelijk letsel te voorkomen wanneer u dit toestel in een rek monteert of het daar een servicebeurt geeft, moet u speciale voorzorgsmaatregelen nemen om ervoor te zorgen dat het toestel stabiel blijft. De onderstaande richtlijnen worden verstrekt om uw veiligheid te verzekeren:

Dit toestel dient onderaan in het rek gemonteerd te worden als het toestel het enige in het rek is.

Wanneer u dit toestel in een gedeeltelijk gevuld rek monteert, dient u het rek van onderen naar boven te laden met het zwaarste onderdeel onderaan in het rek.

Als het rek voorzien is van stabiliseringshulpmiddelen, dient u de stabilisatoren te monteren voordat u het toestel in het rek monteert of het daar een servicebeurt geeft.

Varoitus Kun laite asetetaan telineeseen tai huolletaan sen ollessa telineessä, on noudatettava erityisiä varotoimia järjestelmän vakavuuden säilyttämiseksi, jotta vältytään loukkaantumiselta. Noudata seuraavia turvallisuusohjeita:

Jos telineessä ei ole muita laitteita, aseta laite telineen alaosaan.

Jos laite asetetaan osaksi täytettyyn telineeseen, aloita kuormittaminen sen alaosasta kaikkein raskaimmalla esineellä ja siirry sitten sen yläosaan.

Jos telinettä varten on vakaimet, asenna ne ennen laitteen asettamista telineeseen tai sen huoltamista siinä.

Attention Pour éviter toute blessure corporelle pendant les opérations de montage ou de réparation de cette unité en casier, il convient de prendre des précautions spéciales afin de maintenir la stabilité du système. Les directives ci-dessous sont destinées à assurer la protection du personnel :

Si cette unité constitue la seule unité montée en casier, elle doit être placée dans le bas.

Si cette unité est montée dans un casier partiellement rempli, charger le casier de bas en haut en plaçant l'élément le plus lourd dans le bas.

Si le casier est équipé de dispositifs stabilisateurs, installer les stabilisateurs avant de monter ou de réparer l'unité en casier.

Warning

Warnung Zur Vermeidung von Körperverletzung beim Anbringen oder Warten dieser Einheit in einem Gestell müssen Sie besondere Vorkehrungen treffen, um sicherzustellen, daß das System stabil bleibt. Die folgenden Richtlinien sollen zur Gewährleistung Ihrer Sicherheit dienen:

Wenn diese Einheit die einzige im Gestell ist, sollte sie unten im Gestell angebracht werden.

Bei Anbringung dieser Einheit in einem zum Teil gefüllten Gestell ist das Gestell von unten nach oben zu laden, wobei das schwerste Bauteil unten im Gestell anzubringen ist.

Wird das Gestell mit Stabilisierungszubehör geliefert, sind zuerst die Stabilisatoren zu installieren, bevor Sie die Einheit im Gestell anbringen oder sie warten.

Avvertenza Per evitare infortuni fisici durante il montaggio o la manutenzione di questa unità in un supporto, occorre osservare speciali precauzioni per garantire che il sistema rimanga stabile. Le seguenti direttive vengono fornite per garantire la sicurezza personale:

Questa unità deve venire montata sul fondo del supporto, se si tratta dell'unica unità da montare nel supporto.

Quando questa unità viene montata in un supporto parzialmente pieno, caricare il supporto dal basso all'alto, con il componente più pesante sistemato sul fondo del supporto.

Se il supporto è dotato di dispositivi stabilizzanti, installare tali dispositivi prima di montare o di procedere alla manutenzione dell'unità nel supporto.

Advarsel Unngå fysiske skader under montering eller reparasjonsarbeid på denne enheten når den befinner seg i et kabinett. Vær nøye med at systemet er stabilt. Følgende retningslinjer er gitt for å verne om sikkerheten:

Denne enheten bør monteres nederst i kabinettet hvis dette er den eneste enheten i kabinettet.

Ved montering av denne enheten i et kabinett som er delvis fylt, skal kabinettet lastes fra bunnen og opp med den tyngste komponenten nederst i kabinettet.

Hvis kabinettet er utstyrt med stabiliseringsutstyr, skal stabilisatorene installeres før montering eller utføring av reparasjonsarbeid på enheten i kabinettet.

Aviso Para se prevenir contra danos corporais ao montar ou reparar esta unidade numa estante, deverá tomar precauções especiais para se certificar de que o sistema possui um suporte estável. As seguintes directrizes ajudá-lo-ão a efectuar o seu trabalho com segurança:

Esta unidade deverá ser montada na parte inferior da estante, caso seja esta a única unidade a ser montada.

Ao montar esta unidade numa estante parcialmente ocupada, coloque os itens mais pesados na parte inferior da estante, arrumando-os de baixo para cima.

Se a estante possuir um dispositivo de estabilização, instale-o antes de montar ou reparar a unidade.

Warning

¡Advertencia! Para evitar lesiones durante el montaje de este equipo sobre un bastidor, o posteriormente durante su mantenimiento, se debe poner mucho cuidado en que el sistema quede bien estable. Para garantizar su seguridad, proceda según las siguientes instrucciones:

Colocar el equipo en la parte inferior del bastidor, cuando sea la única unidad en el mismo.

Cuando este equipo se vaya a instalar en un bastidor parcialmente ocupado, comenzar la instalación desde la parte inferior hacia la superior colocando el equipo más pesado en la parte inferior.

Si el bastidor dispone de dispositivos estabilizadores, instalar éstos antes de montar o proceder al mantenimiento del equipo instalado en el bastidor.

Varning! För att undvika kroppsskada när du installerar eller utför underhållsarbete på denna enhet på en ställning måste du vidta särskilda försiktighetsåtgärder för att försäkra dig om att systemet står stadigt. Följande riktlinjer ges för att trygga din säkerhet:

Om denna enhet är den enda enheten på ställningen skall den installeras längst ned på ställningen.

Om denna enhet installeras på en delvis fylld ställning skall ställningen fyllas nedifrån och upp, med de tyngsta enheterna längst ned på ställningen.

Om ställningen är försedd med stabiliseringsdon skall dessa monteras fast innan enheten installeras eller underhålls på ställningen.

Ramp Warning

Warning

When installing the router, do not use a ramp inclined at more than 10 degrees.

Waarschuwing   Gebruik een oprijplaat niet onder een hoek van meer dan 10 graden.

Varoitus   Älä käytä sellaista kaltevaa pintaa, jonka kaltevuus ylittää 10 astetta.

Attention   Ne pas utiliser une rampe dont l'inclinaison est supérieure à 10 degrés.

Warnung   Keine Rampen mit einer Neigung von mehr als 10 Grad verwenden.

Avvertenza   Non usare una rampa con pendenza superiore a 10 gradi.

Advarsel   Bruk aldri en rampe som heller mer enn 10 grader.

Aviso   Não utilize uma rampa com uma inclinação superior a 10 graus.

¡Advertencia!   No usar una rampa inclinada más de 10 grados.

Varning!   Använd inte ramp med en lutning på mer än 10 grader.

Laser and LED Safety Guidelines and Warnings

Single-mode PICs are equipped with laser transmitters, which are considered a Class 1 Laser Product by the U. S. Food and Drug Administration, and they are evaluated as a Class 1 Laser Product per EN60825 requirements.

Observe the following guidelines and warnings related to laser and LED equipment:

- General Laser Safety Guidelines on page 98
- Class 1 Laser Product Warning on page 98
- Laser Beam Warning on page 99
- Radiation From Open Port Apertures on page 100
- Class 1 LED Product Warning on page 101

General Laser Safety Guidelines

Warning

Unterminated optical connectors can emit invisible laser radiation. The lens in the human eye focuses all the laser power on the retina, so even a low-power laser could permanently damage the eye if it is focused directly on the laser source.

When working around PICs, observe the following safety guidelines to prevent eye injury:

- Do not look into unterminated ports or at fibers that connect to unknown sources.
- Do not examine unterminated optical ports with optical instruments.
- Avoid direct exposure to the beam.

Class 1 Laser Product Warning

Warning

Class 1 laser product.

Waarschuwing   Klasse-1 laser produkt.

Varoitus   Luokan 1 lasertuote.

Attention   Produit laser de classe 1.

Warnung   Laserprodukt der Klasse 1.

Avvertenza   Prodotto laser di Classe 1.

Advarsel   Laserprodukt av klasse 1.

Aviso   Produto laser de classe 1.

¡Advertencia!   Producto láser Clase I.

Varning!   Laserprodukt av klass 1.

Laser Beam Warning

Warning

Do not stare into the laser beam or view it directly with optical instruments.

Waarschuwing Niet in de straal staren of hem rechtstreeks bekijken met optische instrumenten.

Varoitus Älä katso säteeseen äläkä tarkastele sitä suoraan optisen laitteen avulla.

Attention Ne pas fixer le faisceau des yeux, ni l'observer directement à l'aide d'instruments optiques.

Warnung Nicht direkt in den Strahl blicken und ihn nicht direkt mit optischen Geräten prüfen.

Avvertenza Non fissare il raggio con gli occhi né usare strumenti ottici per osservarlo direttamente.

Advarsel Stirr eller se ikke direkte p strlen med optiske instrumenter.

Aviso Não olhe fixamente para o raio, nem olhe para ele directamente com instrumentos ópticos.

¡Advertencia! No mirar fijamente el haz ni observarlo directamente con instrumentos ópticos.

Varning! Rikta inte blicken in mot strålen och titta inte direkt på den genom optiska instrument.

Radiation From Open Port Apertures

Warning

Because invisible radiation may be emitted from the aperture of the port when no fiber cable is connected, avoid exposure to radiation and do not stare into open apertures.

Waarschuwing Aangezien onzichtbare straling vanuit de opening van de poort kan komen als er geen fiberkabel aangesloten is, dient blootstelling aan straling en het kijken in open openingen vermeden te worden.

Varoitus Koska portin aukosta voi emittoitua näkymätöntä säteilyä, kun kuitukaapelia ei ole kytkettynä, vältä säteilylle altistumista äläkä katso avoimiin aukkoihin.

Attention Des radiations invisibles à l'il nu pouvant traverser l'ouverture du port lorsqu'aucun câble en fibre optique n'y est connecté, il est recommandé de ne pas regarder fixement l'intérieur de ces ouvertures.

Warnung Warnung: Aus der Port-Öffnung können unsichtbare Strahlen emittieren, wenn kein Glasfaserkabel angeschlossen ist. Vermeiden Sie es, sich den Strahlungen auszusetzen, und starren Sie nicht in die Öffnungen!

Avvertenza Quando i cavi in fibra non sono inseriti, radiazioni invisibili possono essere emesse attraverso l'apertura della porta. Evitate di esporvi alle radiazioni e non guardate direttamente nelle aperture.

Advarsel Unngå utsettelse for stråling, og stirr ikke inn i åpninger som er åpne, fordi usynlig stråling kan emiteres fra portens åpning når det ikke er tilkoblet en fiberkabel.

Aviso Dada a possibilidade de emissão de radiação invisível através do orifício da via de acesso, quando esta não tiver nenhum cabo de fibra conectado, deverá evitar a exposição à radiação e não deverá olhar fixamente para orifícios que se encontrarem a descoberto.

¡Advertencia! Debido a que la apertura del puerto puede emitir radiación invisible cuando no existe un cable de fibra conectado, evite mirar directamente a las aperturas para no exponerse a la radiación.

Varning! Osynlig strålning kan avges från en portöppning utan ansluten fiberkabel och du bör därför undvika att bli utsatt för strålning genom att inte stirra in i oskyddade öppningar.

Class 1 LED Product Warning

Warning

Class 1 LED product.

Waarschuwing Klasse 1 LED-product.

Varoitus Luokan 1 valodiodituote.

Attention Alarme de produit LED Class I.

Warnung Class 1 LED-Produktwarnung.

Avvertenza Avvertenza prodotto LED di Classe 1.

Advarsel LED-produkt i klasse 1.

Aviso Produto de classe 1 com LED.

¡Advertencia! Aviso sobre producto LED de Clase 1.

Varning! Lysdiodprodukt av klass 1.

Operation and Maintenance Safety Guidelines and Warnings

When operating and maintaining the router, follow these guidelines:

- Battery Handling Warning on page 102
- Jewelry Removal Warning on page 103
- Lightning Activity Warning on page 104
- Operating Temperature Warning on page 105
- Product Disposal Warning on page 106

Battery Handling Warning

Warning

Replacing the battery incorrectly might result in an explosion. Replace the battery only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.

Waarschuwing   Er is ontploffingsgevaar als de batterij verkeerd vervangen wordt. Vervang de batterij slechts met hetzelfde of een equivalent type dat door de fabrikant aanbevolen is. Gebruikte batterijen dienen overeenkomstig fabrieksvoorschriften weggeworpen te worden.

Varoitus   Räjähdyksen vaara, jos akku on vaihdettu väärään akkuun. Käytä vaihtamiseen ainoastaan saman- tai vastaavantyyppistä akkua, joka on valmistajan suosittelema. Hävitä käytetyt akut valmistajan ohjeiden mukaan.

Attention   Danger d'explosion si la pile n'est pas remplacée correctement. Ne la remplacer que par une pile de type semblable ou équivalent, recommandée par le fabricant. Jeter les piles usagées conformément aux instructions du fabricant.

Warnung   Bei Einsetzen einer falschen Batterie besteht Explosionsgefahr. Ersetzen Sie die Batterie nur durch den gleichen oder vom Hersteller empfohlenen Batterietyp. Entsorgen Sie die benutzten Batterien nach den Anweisungen des Herstellers.

Avvertenza   Pericolo di esplosione se la batteria non è installata correttamente. Sostituire solo con una di tipo uguale o equivalente, consigliata dal produttore. Eliminare le batterie usate secondo le istruzioni del produttore.

Advarsel   Det kan være fare for eksplosjon hvis batteriet skiftes på feil måte. Skift kun med samme eller tilsvarende type som er anbefalt av produsenten. Kasser brukte batterier i henhold til produsentens instruksjoner.

Aviso   Existe perigo de explosão se a bateria for substituída incorrectamente. Substitua a bateria por uma bateria igual ou de um tipo equivalente recomendado pelo fabricante. Destrua as baterias usadas conforme as instruções do fabricante.

¡Advertencia!   Existe peligro de explosión si la batería se reemplaza de manera incorrecta. Reemplazar la batería exclusivamente con el mismo tipo o el equivalente recomendado por el fabricante. Desechar las baterías gastadas según las instrucciones del fabricante.

Varning!   Explosionsfara vid felaktigt batteribyte. Ersätt endast batteriet med samma batterityp som rekommenderas av tillverkaren eller motsvarande. Följ tillverkarens anvisningar vid kassering av använda batterier.

Jewelry Removal Warning

Warning

Before working on equipment that is connected to power lines, remove jewelry, including rings, necklaces, and watches. Metal objects heat up when connected to power and ground and can cause serious burns or weld the metal object to the terminals.

Waarschuwing Alvorens aan apparatuur te werken die met elektrische leidingen is verbonden, sieraden (inclusief ringen, kettingen en horloges) verwijderen. Metalen voorwerpen worden warm wanneer ze met stroom en aarde zijn verbonden, en kunnen ernstige brandwonden veroorzaken of het metalen voorwerp aan de aansluitklemmen lassen.

Varoitus Ennen kuin työskentelet voimavirtajohtoihin kytkettyjen laitteiden parissa, ota pois kaikki korut (sormukset, kaulakorut ja kellot mukaan lukien). Metalliesineet kuumenevat, kun ne ovat yhteydessä sähkövirran ja maan kanssa, ja ne voivat aiheuttaa vakavia palovammoja tai hitsata metalliesineet kiinni liitäntänapoihin.

Attention Avant d'accéder à cet équipement connecté aux lignes électriques, ôter tout bijou (anneaux, colliers et montres compris). Lorsqu'ils sont branchés à l'alimentation et reliés à la terre, les objets métalliques chauffent, ce qui peut provoquer des blessures graves ou souder l'objet métallique aux bornes.

Warnung Vor der Arbeit an Geräten, die an das Netz angeschlossen sind, jeglichen Schmuck (einschließlich Ringe, Ketten und Uhren) abnehmen. Metallgegenstände erhitzen sich, wenn sie an das Netz und die Erde angeschlossen werden, und können schwere Verbrennungen verursachen oder an die Anschlußklemmen angeschweißt werden.

Avvertenza Prima di intervenire su apparecchiature collegate alle linee di alimentazione, togliersi qualsiasi monile (inclusi anelli, collane, braccialetti ed orologi). Gli oggetti metallici si riscaldano quando sono collegati tra punti di alimentazione e massa: possono causare ustioni gravi oppure il metallo può saldarsi ai terminali.

Advarsel Fjern alle smykker (inkludert ringer, halskjeder og klokker) før du skal arbeide på utstyr som er koblet til kraftledninger. Metallgjenstander som er koblet til kraftledninger og jord blir svært varme og kan forårsake alvorlige brannskader eller smelte fast til polene.

Aviso Antes de trabalhar em equipamento que esteja ligado a linhas de corrente, retire todas as jóias que estiver a usar (incluindo anéis, fios e relógios). Os objectos metálicos aquecerão em contacto com a corrente e em contacto com a ligação à terra, podendo causar queimaduras graves ou ficarem soldados aos terminais.

¡Advertencia! Antes de operar sobre equipos conectados a líneas de alimentación, quitarse las joyas (incluidos anillos, collares y relojes). Los objetos de metal se calientan cuando se conectan a la alimentación y a tierra, lo que puede ocasionar quemaduras graves o que los objetos metálicos queden soldados a los bornes.

Varning! Tag av alla smycken (inklusive ringar, halsband och armbandsur) innan du arbetar på utrustning som är kopplad till kraftledningar. Metallobjekt hettas upp när de kopplas ihop med ström och jord och kan förorsaka allvarliga brännskador; metallobjekt kan också sammansvetsas med kontakterna.

Lightning Activity Warning

Warning

Do not work on the system or connect or disconnect cables during periods of lightning activity.

Waarschuwing Tijdens onweer dat gepaard gaat met bliksem, dient u niet aan het systeem te werken of kabels aan te sluiten of te ontkoppelen.

Varoitus Älä työskentele järjestelmän parissa äläkä yhdistä tai irrota kaapeleita ukkosilmalla.

Attention Ne pas travailler sur le système ni brancher ou débrancher les câbles pendant un orage.

Warnung Arbeiten Sie nicht am System und schließen Sie keine Kabel an bzw. trennen Sie keine ab, wenn es gewittert.

Avvertenza Non lavorare sul sistema o collegare oppure scollegare i cavi durante un temporale con fulmini.

Advarsel Utfør aldri arbeid på systemet, eller koble kabler til eller fra systemet når det tordner eller lyner.

Aviso Não trabalhe no sistema ou ligue e desligue cabos durante períodos de mau tempo (trovoada).

¡Advertencia! No operar el sistema ni conectar o desconectar cables durante el transcurso de descargas eléctricas en la atmósfera.

Varning! Vid åska skall du aldrig utföra arbete på systemet eller ansluta eller koppla loss kablar.

Operating Temperature Warning

Warning

To prevent the router from overheating, do not operate it in an area that exceeds the maximum recommended ambient temperature of 104°F (40°C). To prevent airflow restriction, allow at least 6 inches (15.2 cm) of clearance around the ventilation openings.

Waarschuwing Om te voorkomen dat welke router van de Juniper Networks M160 router dan ook oververhit raakt, dient u deze niet te bedienen op een plaats waar de maximale aanbevolen omgevingstemperatuur van 40°C wordt overschreden. Om te voorkomen dat de luchtstroom wordt beperkt, dient er minstens 15,2 cm speling rond de ventilatie-openingen te zijn.

Varoitus Ettei Juniper Networks M160 router-sarjan reititin ylikuumentuisi, sitä ei saa käyttää tilassa, jonka lämpötila ylittää korkeimman suositellun ympäristölämpötilan 40°C. Ettei ilmanvaihto estyisi, tuuletusaukkojen ympärille on jätettävä ainakin 15,2 cm tilaa.

Attention Pour éviter toute surchauffe des routeurs de la gamme Juniper Networks M160 router, ne l'utilisez pas dans une zone où la température ambiante est supérieure à 40°C. Pour permettre un flot d'air constant, dégagez un espace d'au moins 15 cm autour des ouvertures de ventilations.

Warnung Um einen Router der router vor Überhitzung zu schützen, darf dieser nicht in einer Gegend betrieben werden, in der die Umgebungstemperatur das empfohlene Maximum von 40°C überschreitet. Um Lüftungsverschluß zu verhindern, achten Sie darauf, daß mindestens 15,2 cm lichter Raum um die Lüftungsöffnungen herum frei bleibt.

Avvertenza Per evitare il surriscaldamento dei router, non adoperateli in un locale che ecceda la temperatura ambientale massima di 104°F (40°C). Per evitare che la circolazione dell'aria sia impedita, lasciate uno spazio di almeno sei pollici (15.2 cm) di fronte alle aperture delle ventole.

Advarsel Unngå overoppheting av eventuelle rutere i Juniper Networks M160 router Disse skal ikke brukes på steder der den anbefalte maksimale omgivelsestemperaturen overstiger 40°C (104°F). Sørg for at klaringen rundt lufteåpningene er minst 15,2 cm (6 tommer) for å forhindre nedsatt luftsirkulasjon.

Aviso Para evitar o sobreaquecimento do encaminhador Juniper Networks M160 router, não utilize este equipamento numa área que exceda a temperatura máxima recomendada de 40°C. Para evitar a restrição à circulação de ar, deixe pelo menos um espaço de 15,2 cm à volta das aberturas de ventilação.

¡Advertencia! Para impedir que un encaminador de la serie Juniper Networks M160 router se recaliente, no lo haga funcionar en un área en la que se supere la temperatura ambiente máxima recomendada de 104°F (40°C). Para impedir la restricción de la entrada de aire, deje un espacio mínimo de 6 pulgadas (15,2 cm) alrededor de las aperturas para ventilación.

Varning! Förhindra att en Juniper Networks M160 router överhettas genom att inte använda den i ett område där den maximalt rekommenderade omgivningstemperaturen på 40°C överskrids. Förhindra att luftcirkulationen inskränks genom att se till att det finns fritt utrymme på minst 15,2 cm omkring ventilationsöppningarna.

Product Disposal Warning

Disposal of this product must be handled according to all national laws and regulations.

Waarschuwing Dit produkt dient volgens alle landelijke wetten en voorschriften te worden afgedankt.

Varoitus Tämän tuotteen lopullisesta hävittämisestä tulee huolehtia kaikkia valtakunnallisia lakeja ja säännöksiä noudattaen.

Attention La mise au rebut définitive de ce produit doit être effectuée conformément à toutes les lois et réglementations en vigueur.

Warnung Dieses Produkt muß den geltenden Gesetzen und Vorschriften entsprechend entsorgt werden.

Avvertenza L'eliminazione finale di questo prodotto deve essere eseguita osservando le normative italiane vigenti in materia.

Advarsel Endelig disponering av dette produktet må skje i henhold til nasjonale lover og forskrifter.

Aviso A descartagem final deste produto deverá ser efectuada de acordo com os regulamentos e a legislação nacional.

¡Advertencia! El desecho final de este producto debe realizarse según todas las leyes y regulaciones nacionales.

Varning! Slutlig kassering av denna produkt bör skötas i enlighet med landets alla lagar och föreskrifter.

Agency Approvals

The router complies with the following standards:

- Safety
  - CSA 22.2-No.950/UL 1950 Third Edition - Safety of Information Technology Equipment, Including Electrical Business Equipment
  - EN 60950 Safety of Information Technology Equipment
  - EN 60825-1 Safety of Laser Products - Part 1: Equipment Classification, Requirements and User's Guide
  - EN 60825-2 Safety of Laser Products - Part 2: Safety of Optical Fibre Communication Systems
  - UL 1950

- EMI
  - AS 3548 Class A
  - EN 55022 Class A emissions
  - FCC Class A
  - VCC1 Class 1
- Immunity
  - IEC-61000-3-2 Power Line Harmonics
  - IEC-61000-4-2 ESD
  - IEC-61000-4-3 Radiated Immunity
  - IEC-61000-4-4 EFT
  - IEC-61000-4-5 Surge
  - IEC-61000-4-6 Low Frequency Common Immunity
  - IEC-1000-4-11 Voltage Dips and Sags
- NEBS (designed to meet Level 3 requirements)
  - GR-63-Core: Physical Protection
  - GR-1089-Core: EMC and Safety
- ETSI
  - ETS-300386-2 Switching Equipment

Compliance Statements for EMC Requirements

Canada

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

European Community

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Japan

この装置は、クラス A 情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。 VCCI-A

The above translates as:

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.
VCCI-A

Taiwan

警告使用者:

這是甲類的資訊產品. 在居住的環境中使用時, 可能會造成射頻干擾. 在這種情況下, 使用者會被要求採取某些適當的對策.

United States

The router has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Chapter 7

Prepare to Install the Router

After you have prepared your installation site as described in “Prepare the Site” on page 53, you are ready to begin unpacking and installing the router. It is important to proceed through the installation in the following order:

1. Review safety guidelines as explained in “Regulatory Compliance and Safety Information” on page 73.

2. Follow the instructions in this chapter to unpack the router and verify the parts received.

3. Install the router in the rack, as explained in “Install the Router and Its Components” on page 117.

4. Perform the initial system startup as described in “Power Up the Router” on page 152.

This chapter describes how to prepare to install the router. It discusses the following topics:

Tools Required

To unpack the router and prepare for installation, you need the following tools:

- Phillips (+) screwdrivers, numbers 1 and 2
- Flat-blade (–) screwdrivers, 3/16-in. and 1/4-in.
- 7/16” socket or open-end wrench (for front mounting)
- Electrostatic bags, one for each FPC and PIC removed
- 9/16-in. or 14-mm open-end or socket wrench to remove bracket bolts from the shipping pallet

- Antistatic mat, placed on a flat, stable surface
- ESD grounding wrist strap

General Safety Warnings and Guidelines

To safely install the router, it is important to understand the safety warnings and follow proper safety guidelines. This section discusses the various warnings and guidelines associated with installing the router:

- General Safety Warnings
- General Safety Guidelines

Note

For a complete list of safety warnings and guidelines, refer to the chapter "Regulatory Compliance and Safety Information" on page 73.

General Safety Warnings

The following notes indicate two levels of precautionary guidelines:

Warning

Failure to observe the guidelines in a warning note could result in serious physical injury.

Caution

Failure to observe guidelines included in a cautionary note could result in minor injury, discomfort to you, or severe damage to the router.

General Safety Guidelines

To ensure your safety, always follow all instructions and warnings marked on the router, router components, and accessories. The following are general safety guidelines that you should follow when installing and using the router:

- Perform only those system services that are explicitly described in this installation guide. Make sure that only authorized service personnel perform other system services.
- For protection against shock hazard, verify that all power cords are disconnected before servicing the unit.
- Never install wiring during electrical storms.

- Never install electrical jacks in wet locations unless the jacks are specifically designed for wet environments.
- Operate the router only when the grounding wire is connected.
- Do not open or remove chassis covers or sheet metal parts when instructions are not provided in this manual. Such an action could cause severe electrical shock.
- Do not push or force any objects through any of the openings in the chassis frame. Such an action could result in electrical shock or fire.
- Avoid spilling liquid onto the router chassis or onto any router component. Such an action could cause electrical shock or damage the router.
- Avoid touching uninsulated electrical wires or terminals that have not been disconnected from their power source. Such an action could cause electrical shock.

Prevent Electrostatic Discharge Damage

Many router hardware components are sensitive to damage from static electricity. Some components can be impaired by voltages as low as 30 V. You can easily generate potentially damaging static voltages whenever you handle plastic or foam packing material or if you move components across plastic or carpets. Always take electrostatic discharge (ESD) precautions to prevent intermittent or complete component failures.

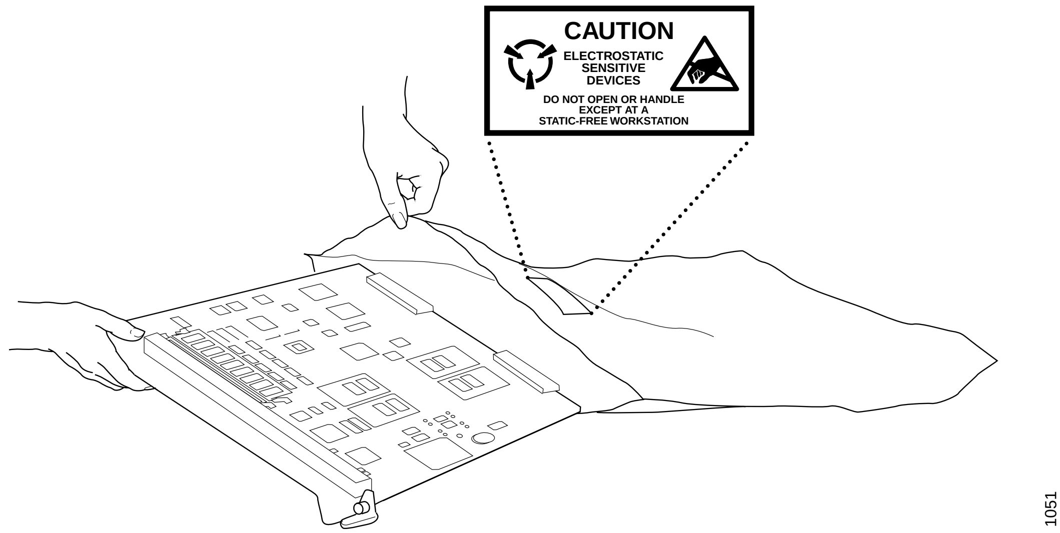
To minimize the potential for ESD damage, observe the following guidelines:

- Always use an ESD wrist strap or ankle strap, and make sure that it is in direct contact with your skin.

> **Caution**
>
> For safety, periodically check the resistance value of the antistatic strap. The measurement should be in the range of 1 to 10 Mohms.

- When handling a removed FPC, PIC, or other component, make sure the equipment end of your ESD strap is attached to one of the electrostatic discharge points on the chassis (see Figure 1 on page 9 and Figure 2 on page 10).
- Avoid contact between the component and your clothing. ESD voltages emitted from clothing can still damage components.
- When removing or installing a component, always place it component-side up on an antistatic surface, in an antistatic card rack, or in an electrostatic bag (see Figure 35). If you are returning the board to the factory, immediately store the component in an electrostatic bag.

Figure 35: Place a Component into an Electrostatic Bag



Rack-Mounting Brackets

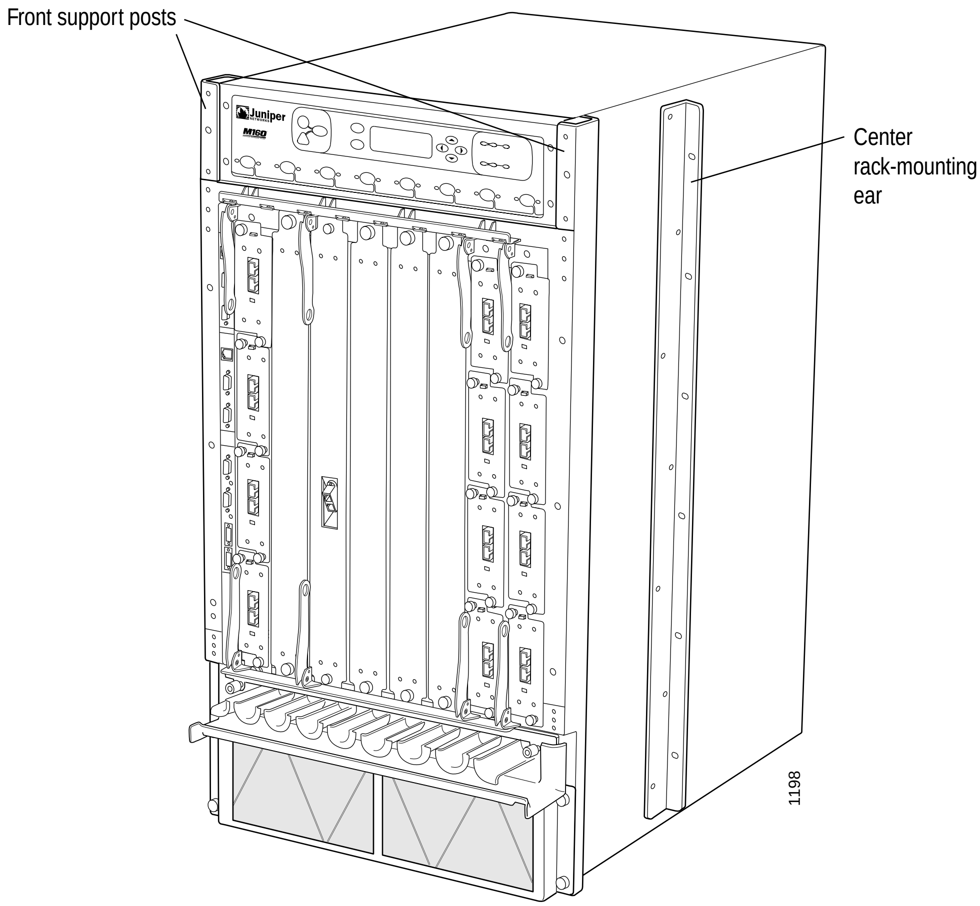
There are two types of rack-mounting brackets for the router:

- Front Support Posts (built into the chassis)
- Center Rack-Mounting Ears (included with the router)

Front Support Posts

The router has two front support posts built into the sides of its chassis (see Figure 36). The support posts have holes for front-mounting bolts.

Figure 36: Chassis Showing Front and Center Mounting Brackets



Center Rack-Mounting Ears

The router has two center rack-mounting ears, mounted along the middle of each side of the chassis (see Figure 36). The ears have holes for mounting screws.

Unpack the Router

The router is shipped in a wooden crate (see Figure 37). A wooden pallet forms the bottom of the crate. The router chassis is bolted to this pallet. A cardboard accessory box is also included in the shipping crate.

> **Note**
>
> Because the router is protected inside its shipping carton, we recommend that you not unpack it until you are ready to install it.

To unpack the system, follow these steps (see Figure 37):

1. Move the shipping crate to a staging area as close to the installation site as possible, where you have enough room to remove the system components. While the chassis is bolted to the pallet, you can use a forklift to move the chassis.

2. Position the shipping crate so that the arrows are pointing up.

3. Open the front flaps on the shipping crate.

4. Lift the top and sides off the pallet.

5. Remove the plastic cover, then the foam and poster that are sitting on top of the chassis. The installation handle and accessory box are embedded in cutouts in the foam.

6. Verify the contents of the shipping crate against the packing list (see Table 24).

7. Open the accessory box and verify the contents against the parts inventory on the label attached to the box (see Table 25).

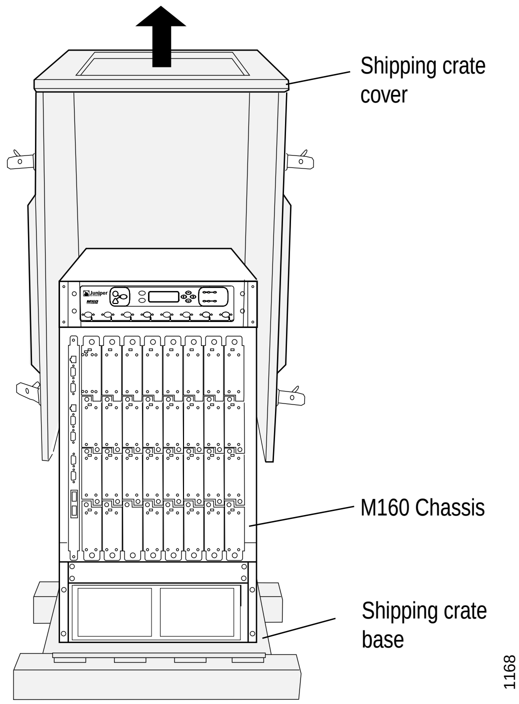
8. To remove the chassis from the pallet, use a 9/16-in. socket wrench to remove the bolts from the brackets that attach the chassis to the pallet. If a 9/16-in. tool is not available, use pliers or an adjustable wrench rather than a metric open-end or socket wrench.

9. Store the brackets and lugs inside the accessory box.

10. Save the shipping carton, packing materials, and pallet in case you need to move or ship the system at a later time.

11. To install the router once it has been unpacked, see “Install the Router and Its Components” on page 117.

Figure 37: Contents of the Shipping Carton



Verify Parts Received

A packing list is included in each shipment. Check the parts you were shipped against the items in the packing list. The packing list specifies the part numbers and descriptions of each part in your order. In general, each router is shipped fully configured.

If any part is missing, contact a customer service representative.

The main shipment contains the chassis with installed components, which contains the parts listed in Table 24, and an accessory box, which contains the parts listed in Table 25.

Table 24: Router Parts List

Component	Quantity
SFMs	4
FPCs preconfigured with up to 4 PICs each	Up to 8
PICs	Up to 4 per FPC
Routing Engine	1
MCS	1
PCGs	2
CIP	1
Midplane	1
Power supplies	2
Circuit breaker box	1
Front upper impeller tray with craft interface	1
Front fan tray with 4 fans and cable management system	1
Rear upper impeller assembly	1
Rear lower impeller assembly	1
Center rack-mounting ears	2
Blank panels for slots without components	(varies depending on router configuration)

Table 25: Accessories Box Parts List

Part Description	Quantity Shipped
Front mounting bolts	8
Installation lifting handle	1
Nuts/washers for circuit breaker box	16/32
ESD wrist strap plus cable	1
PCMCIA card containing backup copy of JUNOS Internet software	1
Software license agreement	1
Serial cable to link Routing Engine to management console	1
Ethernet cable, 15-foot length with RJ-45/RJ-45 connectors	1
DB-9/DB-25 adapter	1
M160 Internet Backbone Router Hardware Installation Guide (this manual)	1
Hardware release notes	1
Software release notes	1
CD-ROM containing documentation	1
Read-me first document (on the outside of the box)	1

Chapter 8

Install the Router and Its Components

Before installing the router, you should have prepared your site and reviewed the guidelines given in “Prepare the Site” on page 53, and unpacked the router from the packing crate, as described in “Prepare to Install the Router” on page 109.

There are two methods of installing the router, either using a mechanical lift or lifting it manually into the rack. Because of the router’s size and weight, we recommend using a mechanical lift to install the router. This chapter describes both methods, and describes connecting external devices, PIC cables, and power cables to the router after it is installed in the rack.

This chapter discusses the following topics:

Tools and Parts Required

You need the following tools and parts to install the router and its components:

- Mechanical lift (recommended)
- Phillips (+) screwdrivers, numbers 1 and 2
- 7/16-in. open-end or socket wrench (if you are installing the router using the front support posts)
- 2.5 mm flat-blade (–) screwdriver, for alarm relay terminal block
- 5/32-in. Allen (hexagonal) wrench for tightening the mounting screws provided in the accessory box; do not substitute a metric-size wrench

- 7/16-in. nut driver or wrench for tightening nuts to terminal studs on circuit breaker box; if a 7/16-in. tool is not available, use pliers or an adjustable wrench rather than a metric nut driver or wrench
- Wire cutters
- Pliers
- Electrostatic bags or antistatic mats, one for each electronic component removed during installation without a mechanical lift
- ESD grounding wrist strap

Install the Router Using a Mechanical Lift

Because of the router’s size and weight (between 190 lbs and 370 lbs depending on configuration), we recommend that you install the router using a mechanical lift. If you install the router using a lift, you can install the complete system without removing the components from the chassis.

The lift must be capable of handling the router’s weight, and should be able to fit between the support posts of the rack.

To install the router using a mechanical lift, use the following procedure:

1. Install the Router into the Rack Using a Lift on page 118
2. Verify That the Router Is Installed Correctly on page 119
3. Connect the Router to External Devices on page 145
4. Connect the PIC Cables on page 149
5. Connect Power to the Router on page 151

Install the Router into the Rack Using a Lift

Before beginning the following procedure to install the router into the rack, remove the router on its pallet from the packing crate as described in “Unpack the Router” on page 114.

Caution

If you are installing two routers in one rack, install the lower one first.

Before installing the router, read the safety information in “Operating Temperature Warning” on page 105.

To install the router into the rack using a mechanical lift, follow this procedure:

1. Place the rack in its permanent location, making sure that you have secured the rack to the building and that you have allowed adequate clearance for both air flow and maintenance. For details, see “Prepare the Site” on page 53.

2. Load the router onto the lift, making sure it rests securely on the platform of the lift.

3. Using the lift, position the router in the rack at the correct height.

4. Starting at the bottom of the rack, align one of its mounting holes with the bottom mounting hole in the chassis rack-mounting rail.

5. Level the chassis so that the same mounting hole on the other chassis rack-mounting rail is aligned with a hole in the rack.

6. Install one of the mounting screws provided into each of the two aligned holes.

7. Moving up the chassis rack-mounting rail, install screws in every mounting hole on the rail until you reach the top.

8. When you are finished, move the lift away from the rack.

Verify That the Router Is Installed Correctly

If the router has been installed properly in the rack, all the mounting screws on one side of the rack should be aligned with the mounting screws on the opposite side and the router should be level.

To complete the installation process, use the procedures in the following sections: “Connect the Router to External Devices” on page 145, “Connect the PIC Cables” on page 149, and “Connect Power to the Router” on page 151.

Install the Router Manually

If you cannot use a mechanical lift to install the router, you can install it manually into the rack. Before installing the router manually, you must first remove the components from the chassis. Three or more people are needed to safely lift the chassis into the rack. After removing the components, the chassis weighs approximately 110 lbs (50 kg). The heaviest components are the FPCs and the front impeller assembly.

To install the router manually, use the following procedure:

1. Remove Components from the Chassis on page 120

2. Install the Chassis into the Rack on page 132

3. Verify That the Chassis Is Installed Correctly on page 134

4. Reinstall Components into the Chassis on page 135

5. Connect the Router to External Devices on page 145

6. Connect the PIC Cables on page 149

7. Connect Power to the Router on page 151

Remove Components from the Chassis

To make the router light enough to install manually, you first remove most of the components from the chassis. The procedures given in this section for removing components from the chassis assume that you have not connected power cables to the router. The following procedures describe how to remove components from the chassis:

- From the back of the chassis:

  1. Remove the Power Supplies on page 121
  2. Remove the Rear Component Cover on page 122
  3. Remove the SFMs on page 122
  4. Remove the MCS on page 123
  5. Remove the PCGs on page 124
  6. Remove the Routing Engine on page 125
  7. Remove the Rear Upper Impeller Assembly on page 126
  8. Remove the Rear Lower Impeller Assembly on page 127

- From the front of the chassis:

  1. Remove the Fan Tray on page 128
  2. Remove the FPCs on page 129
  3. Remove the Front Upper Impeller Assembly on page 131

Note: The following procedures apply only to the initial installation of the router. It is assumed that you have not connected power to the router. If you are installing or replacing components when your router is operational, refer to the appropriate maintenance chapters in Part 3.

Caution: Do not remove the CIP or the circuit breaker box when installing the router.

Table 26 summarizes the weight of the chassis and major components.

Table 26: Chassis Component Weights

Component	Approximate Weight (lbs)	Approximate Weight (kg)
Chassis (with midplane, CIP and circuit breaker box)	113.5	51.5
FPC with 4 PICS, in FPC carrier	15	6.8
SFM	5	2.3
PCG	0.75	0.34
Routing Engine	1.5	0.7
MCS	2.5	1.1
Front upper impeller with craft interface	14.5	6.6
Front fan tray	13	5.9
Rear lower impeller assembly	5	2.3
Rear upper impeller assembly	4	1.8
Air filter	2	0.9
Power supply	13	5.9
Cable management system	1	0.5

Remove the Power Supplies

The router has two DC power supplies, which are located at the bottom rear of the chassis. Each power supply weighs approximately 13 lbs (6 kg).

To remove each of the power supplies, use the following procedure (see Figure 38):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Turn the circuit breakers on the circuit breaker box to the OFF position.

3. Loosen the thumbscrews at each corner of the power supply faceplate.

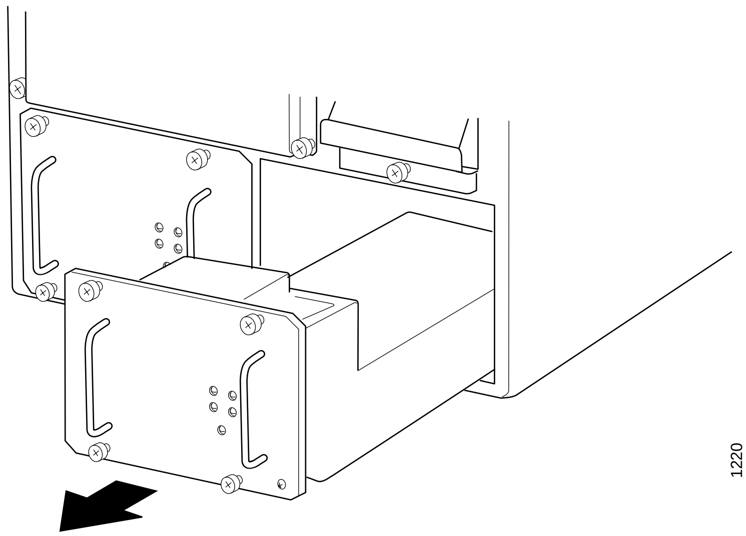
> **Note**
>
> You will probably need a screwdriver to loosen the thumbscrews.

4. Grasp the handles on the power supply faceplate and slide the unit about halfway out of the chassis. A firm pull is needed to start the unit out of the chassis.

5. Move one of your hands underneath the unit to support it, and slide it completely out of the chassis.

6. To remove the second power supply, repeat Steps 3 through 5.

Figure 38: Remove a Power Supply



Remove the Rear Component Cover

The rear component cover protects the SFMs, RE, MCS, and PCGs installed in the rear of the chassis. To remove the component cover, use the following procedure:

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Loosen the four screws on the corners of the component cover.

3. Pull the cover straight out from the chassis.

Remove the SFMs

The router can have from one to four SFMs installed. The SFMs are located in the rear of the chassis, in the slots labeled SFM0 through SFM3. Each SFM weighs approximately 5 lbs (2.3 kg).

To remove each SFM, use the following procedure (see Figure 39):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Loosen the thumbscrews on the ejector locking tabs joining the two SFM boards.

> **Note**
>
> You will probably need a screwdriver to loosen the thumbscrews.

3. Flip the ends of the ejector handles outward.

4. Grasp the handles and slide the unit about three-fourths of the way out of the chassis, pulling firmly to start the unit out of the chassis.

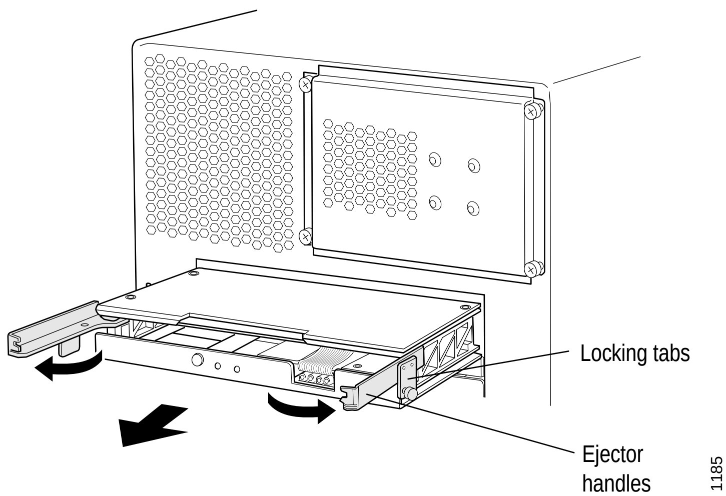
5. Move one of your hands underneath the unit to support it, and slide it completely out of the chassis.

6. To remove the remaining SFMs, repeat Steps 2 through 5 for each SFM.

Caution

Do not stack the SFMs. The power connectors on each SFM can be damaged if the SFMs are stored in a way that puts pressure on the connectors.

Figure 39: Remove an SFM



Remove the MCS

The router can have one or two MCSs installed. One MCS is located in the slot labeled MCS0 in the rear of the chassis, and the second MCS is located in the slot labeled MCS1. Each MCS weighs approximately 2.5 lbs (1 kg).

To remove the MCS, use the following procedure (see Figure 40):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

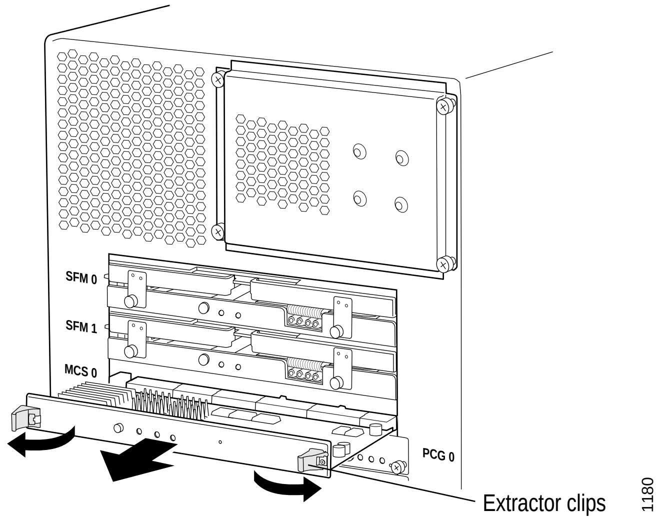
2. Flip the ends of the extractor clips outward.

3. Grasp the extractor clips and slide the unit about halfway out of the chassis.

4. Move one of your hands underneath the unit to support it, and slide it completely out of the chassis.

5. To remove the second MCS, repeat Steps 2 through 4.

Figure 40: Remove an MCS



Remove the PCGs

The router has two PCGs installed. They are located in the rear of the chassis in the slots labeled PCG0 and PCG1. Each PCG weighs approximately 1 lb (0.5 kg).

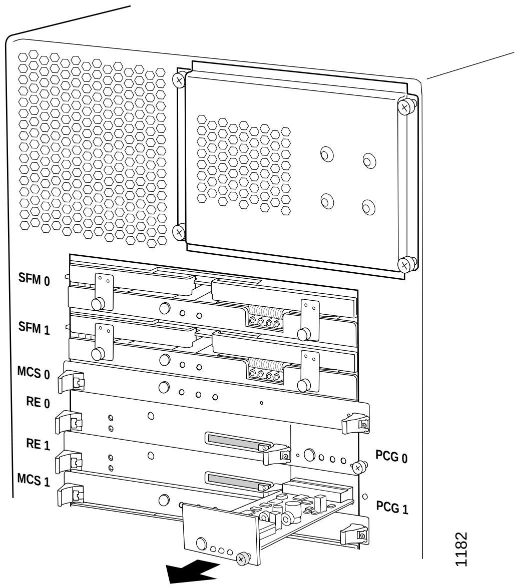
To remove the PCGs, use the following procedure (see Figure 41):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Loosen the mounting screw on the right edge of the PCG faceplate.
3. Grasp the screw and slide the PCG about halfway out of the chassis.
4. Move one of your hands under the PCG to support it, and slide the unit completely out of the chassis.

> **Caution**
>
> Be careful to pull the PCG straight out of the chassis so you do not bend any of the pins on the underside of the board.

5. To remove the second PCG, repeat Steps 2 through 4.

Figure 41: Remove a PCG



Remove the Routing Engine

The router can have one or two Routing Engines installed. They are located in the rear of the chassis in the slots labeled RE0 and RE1. Each Routing Engine weighs approximately 1.5 lbs (0.7 kg).

To remove the Routing Engine, use the following procedure (see Figure 42):

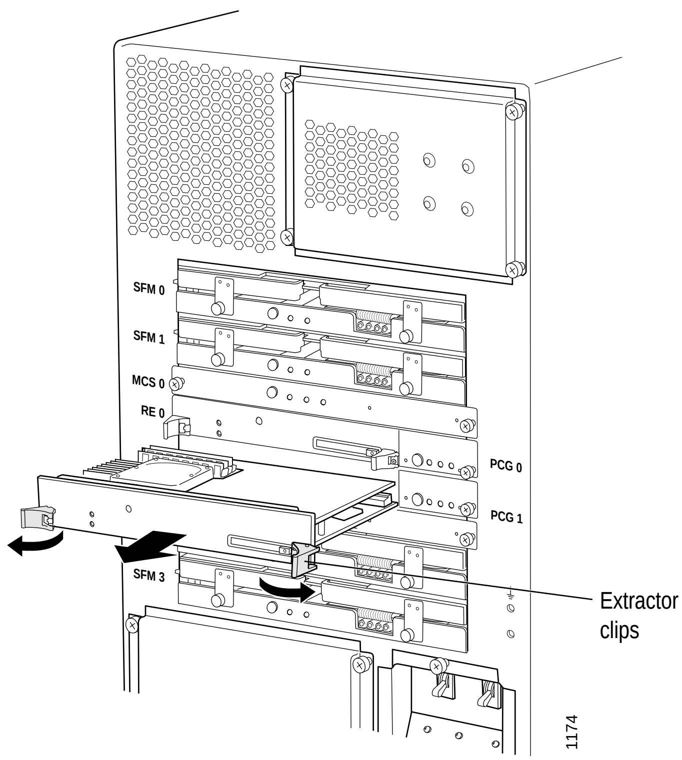
1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Loosen the screws on the extractor clips on either side of the Routing Engine faceplate.
3. Flip the ends of the extractor clips outward.
4. Grasp the extractor clips and slide the unit about halfway out of the chassis.
5. Move one of your hands underneath the unit to support it, and slide it completely out of the chassis.

Caution	When removing the Routing Engine, slide the unit out evenly. If you pull one side out ahead of the other side, the unit could get lodged in the rail and become damaged.

6. To remove the second Routing Engine, repeat Steps 2 through 5.

> **Caution**
>
> Do not stack the Routing Engines. The top of the Routing Engine, especially the hard drive, can be damaged by contact.

Figure 42: Remove a Routing Engine



Remove the Rear Upper Impeller Assembly

The rear upper impeller assembly is located at the rear of the chassis, above the SFMs. The assembly weighs approximately 4 lbs (1.8 kg).

To remove the rear upper impeller assembly, use the following procedure (see Figure 43):

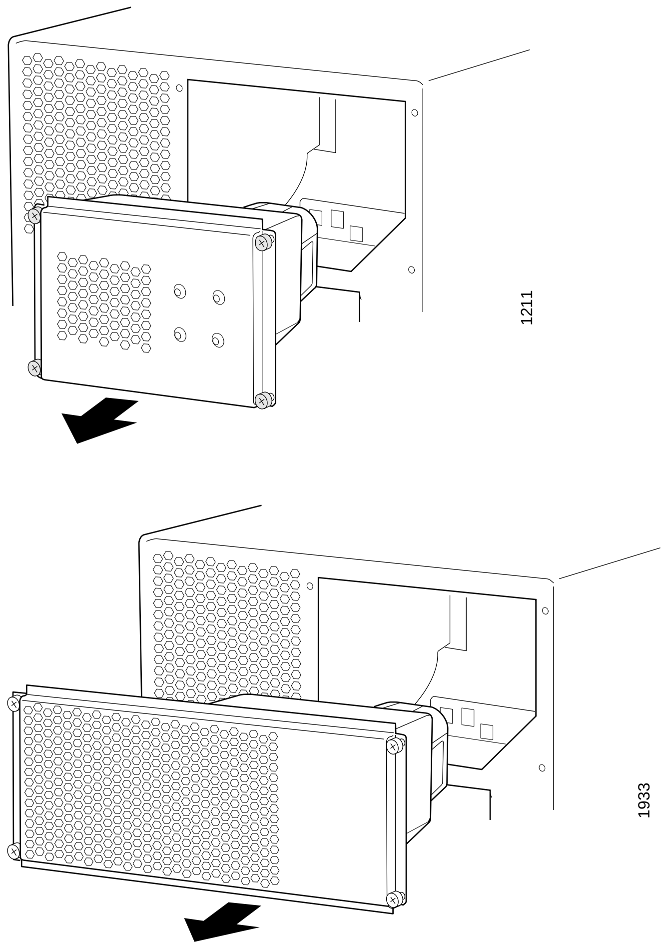
1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Loosen the captive screws at the corners of the impeller cover.

3. Grasp the screws at opposite corners of the impeller cover and slide the assembly out from the chassis.

   There are two types of impeller assemblies, shown in Figure 43.

Figure 43: Remove the Rear Upper Impeller Assembly



Remove the Rear Lower Impeller Assembly

The rear lower impeller assembly is located at the rear of the chassis, to the left of the circuit breaker box. The assembly weighs approximately 5 lbs (2.3 kg).

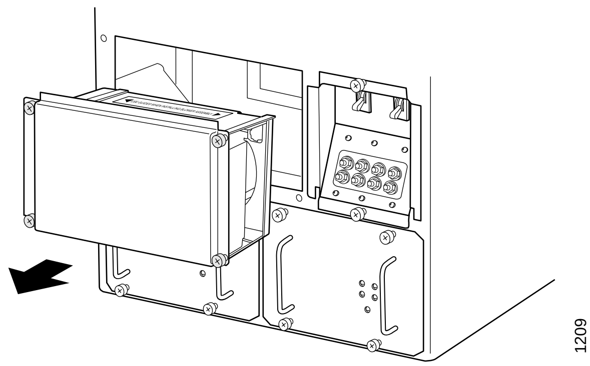
To remove the rear lower impeller assembly, use the following procedure (see Figure 44):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Loosen the screws at the corners of the impeller cover.

3. Grasp the sides of the impeller assembly and slide it out from the chassis.

Figure 44: Remove the Rear Lower Impeller Assembly



Remove the Fan Tray

The fan tray, together with the cable management system, is located at the front of the chassis, just above the air filter. The fan tray contains four fans, and weighs approximately 13 lbs (5.9 kg).

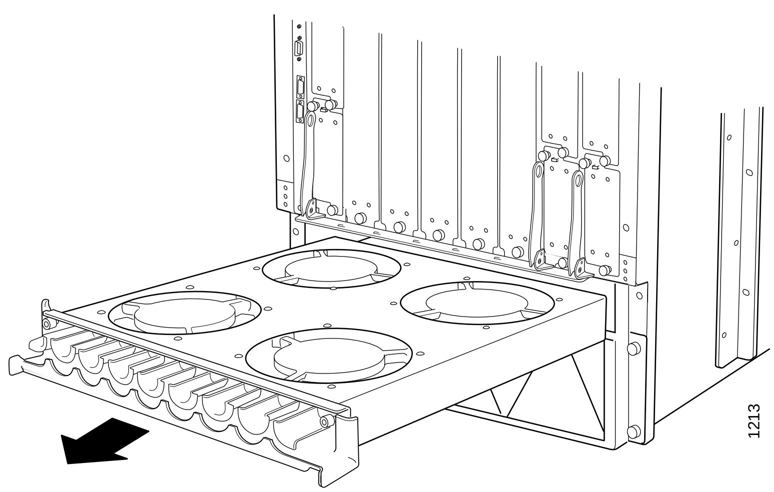
To remove the fan tray, use the following procedure (see Figure 45):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Loosen the screws on the left and right sides of the fan tray.

3. Grasp the sides of the fan tray and pull firmly to slide it out from the chassis.

Figure 45: Remove the Fan Tray



Remove the FPCs

The FPCs are mounted vertically in the FPC card cage. From one to eight FPCs can be installed in the router. Each FPC, fully configured with four PICs, weighs about 15 lbs (6.8 kg). FPC slots without an FPC installed require an FPC blank panel.

Note: For purposes of organization, the following procedure directs you to remove FPCs starting at the left side of the card cage and working toward the right. FPCs can be removed in any order. Whatever order you use, label each FPC as you remove it, noting its slot number and media type (see Table 27).

Table 27: FPC Removal Checklist

Slot	Media Type	Date Removed	Date Reinstalled
0			
1			
2			
3			
4			
5			
6			
7			

To remove the FPCs, use the following procedure (see Figure 46):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. As you face the front of the chassis, locate the FPC at the left side of the card cage. Note that the offline button directly above this FPC (on the craft interface) is labelled `FPC0`.

3. Loosen the captive screws at the top and bottom of the FPC. If the slot contains an FPC blank, loosen the captive screws and pull the blank out from the chassis.

4. Flip the ends of the ejector levers, located at the top and bottom of the FPC, to a nearly horizontal position to dislodge the FPC.

Note: You can also loosen the ejector levers on all the FPCs before starting to remove them.

5. Grasp the top and bottom flanges of the card carrier and slide the FPC about halfway out from the card cage.

> **Caution**
> Avoid grasping the ejector levers, bus bars, or edge connectors of the FPC while removing it. They cannot support the weight of the FPC.

6. Place one hand around the front of the FPC (the PIC housing) and the other hand on the bottom of the FPC.

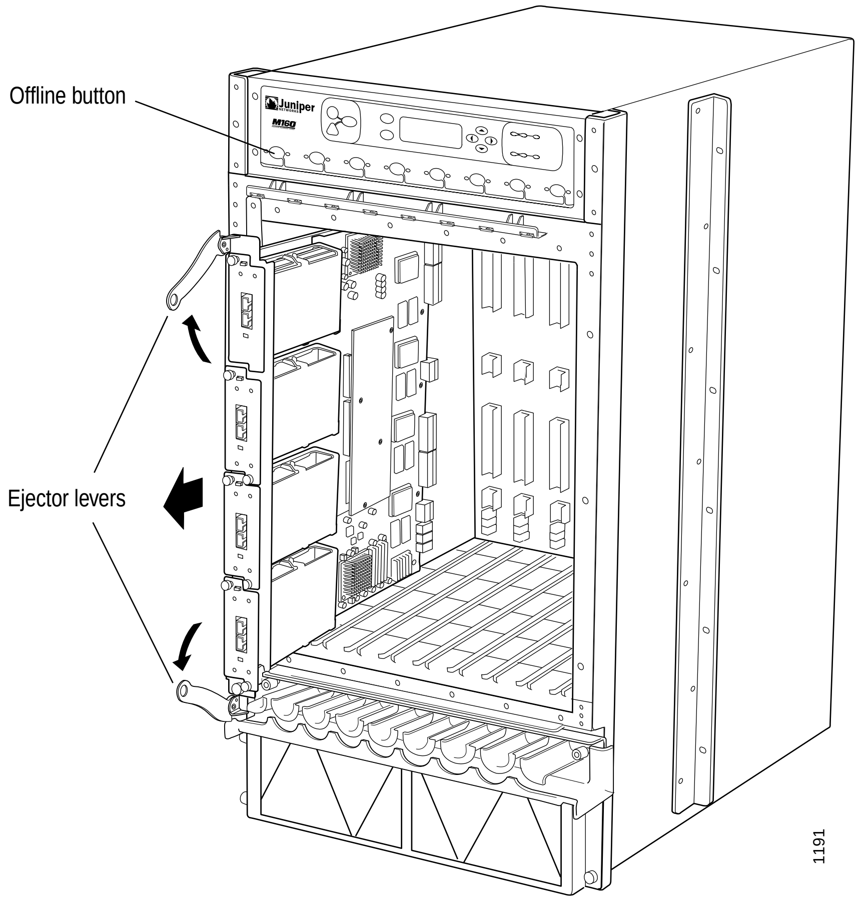
> **Caution**
> The weight of the FPC is concentrated in the back end. Be prepared to accept the full weight as you pull the FPC out of the chassis.

7. Pull the FPC completely out from the chassis.

> **Caution**
> Do not stack the FPCs after you remove them.

8. Moving from left to right, remove the remaining FPCs, labeled FPC1 through FPC7, in the same manner.

Figure 46: Remove an FPC



Remove the Front Upper Impeller Assembly

The front upper impeller assembly is located at front of the chassis above the FPC card cage. The upper impeller assembly, including the craft interface, weighs approximately 14.5 lbs (6.6 kg).

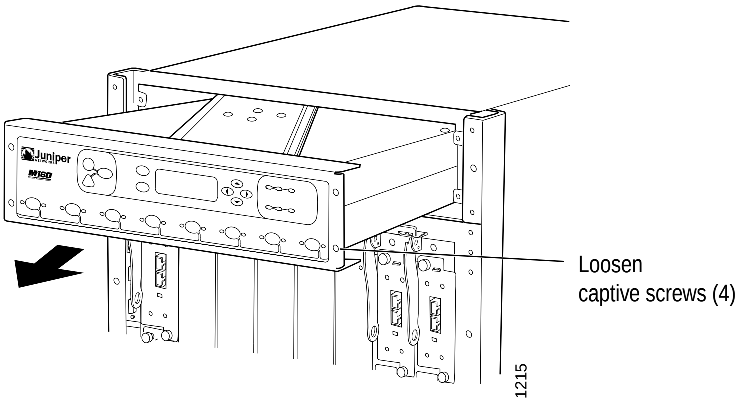
To remove the front upper impeller assembly, use the following procedure (see Figure 47):

1. Attach an ESD wrist strap to your bare wrist and connect the wrist strap to one of the two ESD points on the chassis.

2. Loosen the screws on the corners of the impeller assembly.

3. Grasp the sides of the upper impeller assembly, and slide it out from the chassis.

Figure 47: Remove the Front Upper Impeller Assembly



Install the Chassis into the Rack

Before beginning the following procedure to install the chassis into the rack, remove the chassis on its pallet from the packing crate as described in “Prepare to Install the Router” on page 109.

Warning	Lifting the chassis and mounting it into a rack requires three people to lift and a fourth person to secure the mounting screws. The empty chassis weighs approximately 113.5 lbs (51.5 kg).

Warning	Unless you are using a mechanical lift, do not attempt to load the chassis into the rack without removing the heaviest components first, as described in “Remove Components from the Chassis” on page 120.

Caution	If you are installing two routers in one rack, install the lower one first.

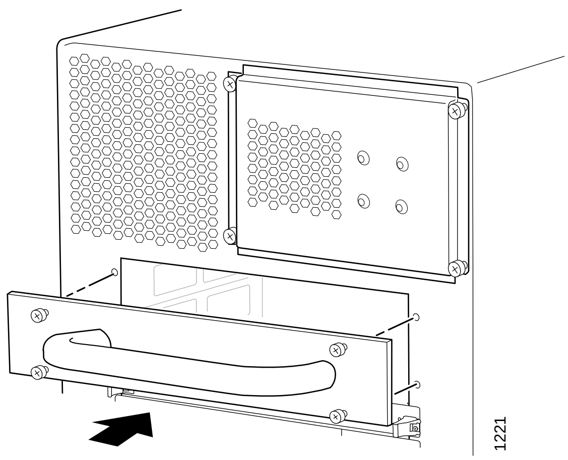
Before installing the router, read the safety information in “Operating Temperature Warning” on page 105.

To install the chassis into the rack, follow this procedure (see Figure 49):

1. Place the rack in its permanent location, making sure that you have secured the rack to the building and that you have allowed adequate clearance for both air flow and maintenance. For details, see "Prepare the Site" on page 53.

2. Install the lifting handle in the rear of the chassis by screwing the captive screws on the handle in the holes next to the SFM slots on the chassis (see Figure 48). If you are installing the chassis in a lower rack space, use the upper set of holes (for SFM0 and SFM1). If you are installing the chassis in an upper rack space, use the lower set of holes (for SFM2 and SFM3).

Figure 48: Installation Lifting Handle



3. With one person grasping the lifting handle, and two people each placing one hand on the bar across the bottom of the FPC card cage and grasping the bottom of the chassis with the second hand, lift the chassis and position it in the rack.

4. Starting at the bottom of the rack, align one of its mounting holes with the bottom mounting hole in the chassis rack-mounting rail.

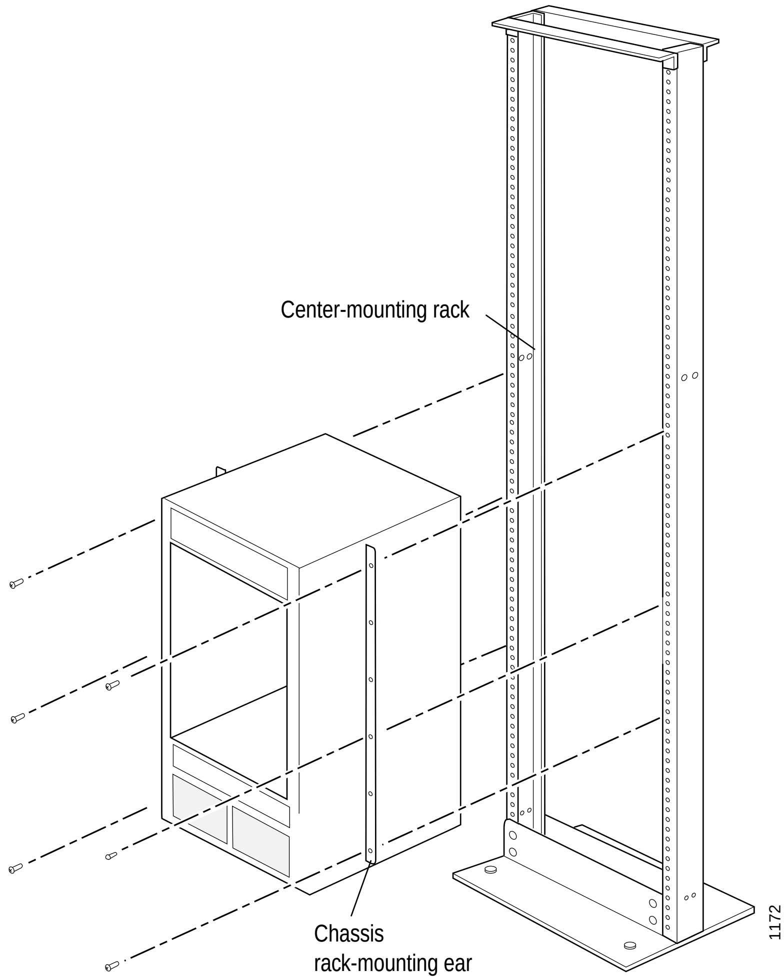
5. Level the chassis so that the same mounting hole on the other chassis rack-mounting rail is aligned with a hole in the rack.

6. Install one of the mounting screws provided into each of the two aligned holes.

7. Moving up the chassis rack-mounting rail, install screws in every mounting hole on the rail until you reach the top.

8. When you are finished, loosen the captive screws on the lifting handle and remove it from the chassis.

Figure 49: Install the Chassis in a Rack



Verify That the Chassis Is Installed Correctly

If the chassis has been installed properly in the rack, all the mounting screws on one side of the rack should be aligned with the mounting screws on the opposite side and the router should be level.

Reinstall Components into the Chassis

After you have successfully mounted the chassis in the rack, you reinstall the router components into the chassis. You reinstall the components in the front of the chassis first, then those in the back of the chassis:

- In the front of the chassis:
  1. Reinstall the Front Upper Impeller Assembly on page 135
  2. Reinstall the FPCs on page 136
  3. Reinstall the Fan Tray on page 138
- In the rear of the chassis:
  1. Reinstall the Rear Lower Impeller Assembly on page 138
  2. Reinstall the Rear Upper Impeller Assembly on page 139
  3. Reinstall the Routing Engine on page 140
  4. Reinstall the PCGs on page 141
  5. Reinstall the MCS on page 142
  6. Reinstall the SFMs on page 143
  7. Reinstall the Rear Component Cover on page 144
  8. Reinstall the Power Supplies on page 144
  9. Connect the Router to External Devices on page 145

> **Note**
>
> The following procedures apply only to the initial installation of the router. It is assumed that you have not connected power to the router. If you are installing or replacing components when your router is operational, refer to the appropriate maintenance chapters in Part 3. Failure to do so could result in damage to the router or network traffic being interrupted.

Reinstall the Front Upper Impeller Assembly

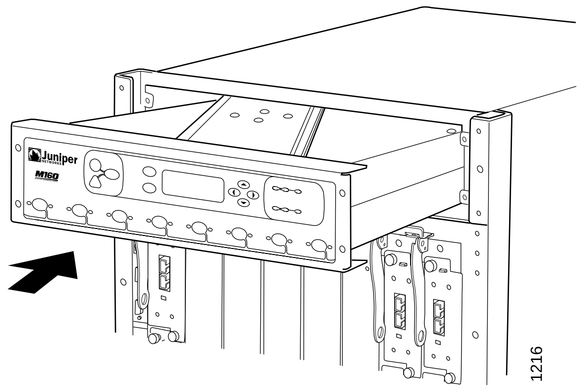
To reinstall the front upper impeller assembly, together with the craft interface, at the top of the front of the chassis, use the following procedure (see Figure 50):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Grasp the sides of the impeller assembly, and align the rear of the assembly with the guides inside the chassis.

3. Slide the impeller assembly all the way into the chassis.

4. Tighten the four captive screws at the corners of the impeller assembly.

Figure 50: Reinstall the Front Upper Impeller Assembly



Reinstall the FPCs

You reinstall each FPC in the slot in the card cage from which you removed it. FPC slots without an FPC installed require an FPC blank panel.


Note

For purposes of organization, the following procedure directs you to install FPCs starting at the left end of the FPC card cage and working toward the right. FPCs can be installed in any order.

When installing multiple FPCs, allow 30 seconds between each FPC.

To reinstall the FPCs, use the following procedure (see Figure 51):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. As you face the front of the chassis, locate the FPC slot at the left side of the card cage. Note that the offline button above this FPC slot is labeled FPC0.

3. Locate the FPC that you labeled FPC0.

4. Grasp the front of the card carrier, and align the rear of the FPC with the bottom guides for the slot.

5. Slide the FPC all the way into the card cage until it contacts the midplane.

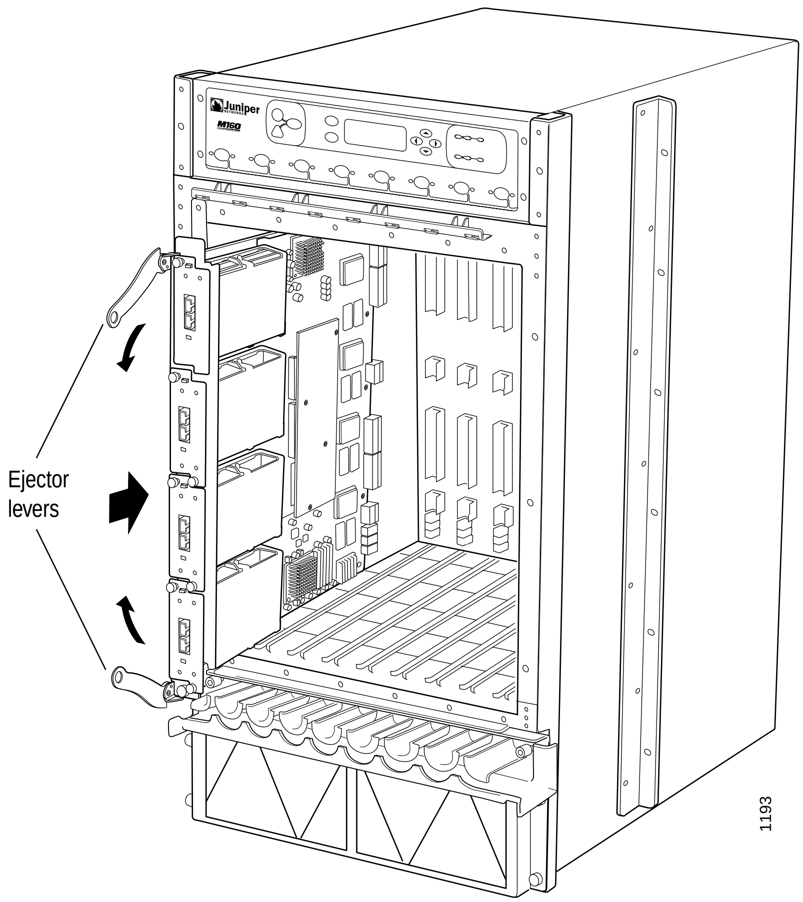
6. Press the ends of the ejector levers, located at the top and bottom of the card carrier, toward each other to secure the FPC into place.

7. Tighten the captive screws at the top and bottom of the FPC to secure it to the chassis.

> **Note**
>
> To seat the FPCs properly, be sure to tighten the screws adequately.

8. Moving from left to right, install the remaining FPCs into the appropriate slots, as described in Steps 4 through 7.

Figure 51: Reinstall an FPC



Reinstall the Fan Tray

To reinstall the fan tray above the air filter at front of the chassis, use the following procedure (see Figure 52):

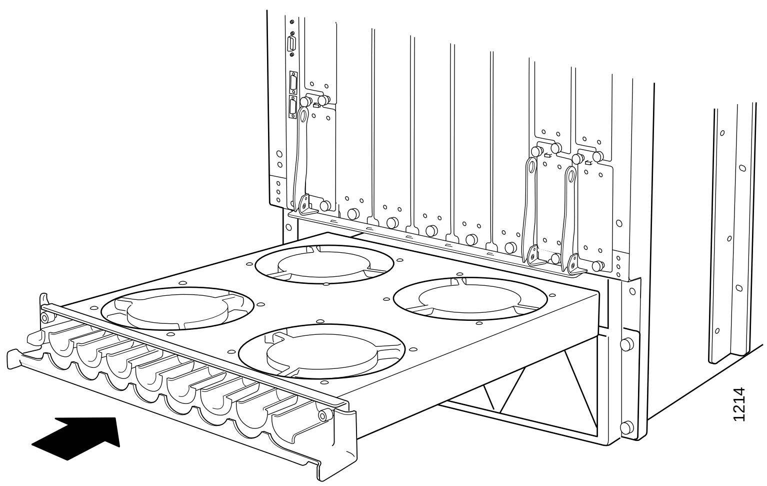
1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Grasp the sides of the fan tray, and align the rear of the tray with the guides inside the chassis.

3. Slide the fan tray all the way into the chassis.

4. Tighten the captive screws on the left and right sides of the fan tray.

Figure 52: Reinstall the Fan Tray



Reinstall the Rear Lower Impeller Assembly

To reinstall the rear lower impeller assembly in the rear of the chassis, use the following procedure (see Figure 53):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

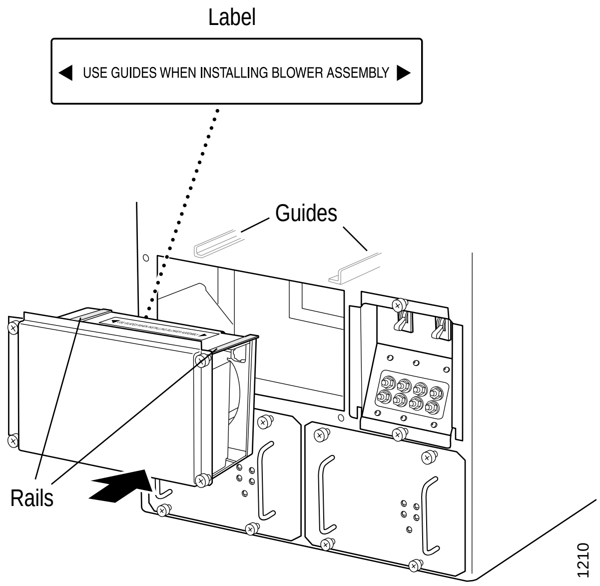
2. Align the rails on the upper edges of the impeller assembly with the guides inside the chassis.

3. Push the impeller assembly up and to the right to start it into the chassis.

4. Slide the impeller assembly into the chassis.

5. Tighten the captive screws on the corners of the impeller cover.

Figure 53: Reinstall the Rear Lower Impeller Assembly



Reinstall the Rear Upper Impeller Assembly

To reinstall the rear upper impeller assembly in the rear of the chassis, use the following procedure (see Figure 54):

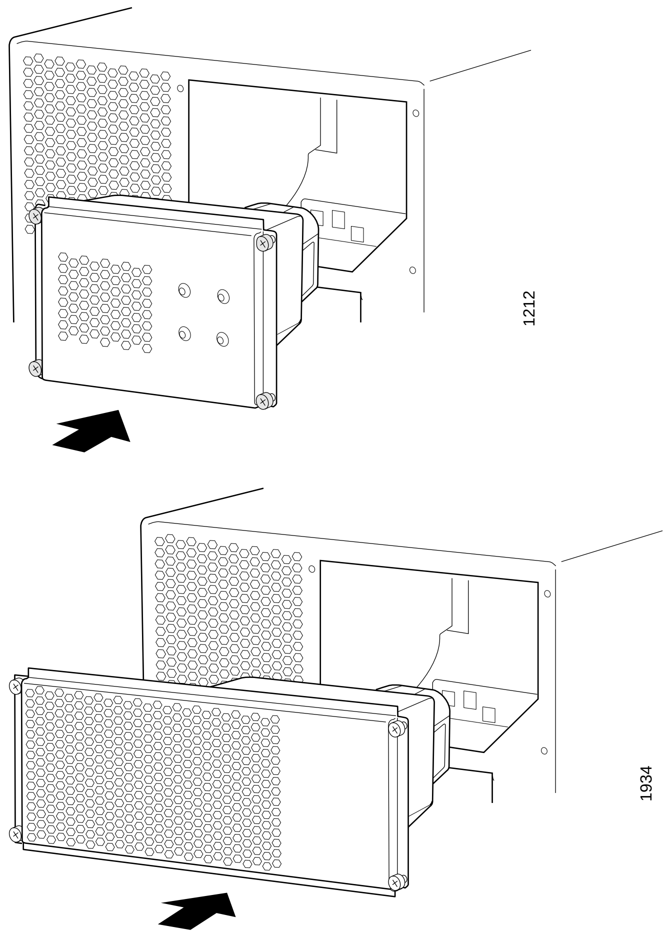
1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Grasp the handle at the top of the impeller assembly and slide the assembly all the way into the chassis.

3. Tighten the captive screws on the corners of the impeller cover.

   There are two types of impeller assemblies, shown in Figure 54.

Figure 54: Reinstall the Rear Upper Impeller Assembly



Reinstall the Routing Engine

To reinstall the Routing Engine in the rear of the chassis, use the following procedure (see Figure 55):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Hold the Routing Engine unit by placing one hand underneath to support it and the other hand on one of the extractor clips on the faceplate.

3. Align the rear of the unit with the guides inside the chassis.

4. Slide the unit completely into the chassis.

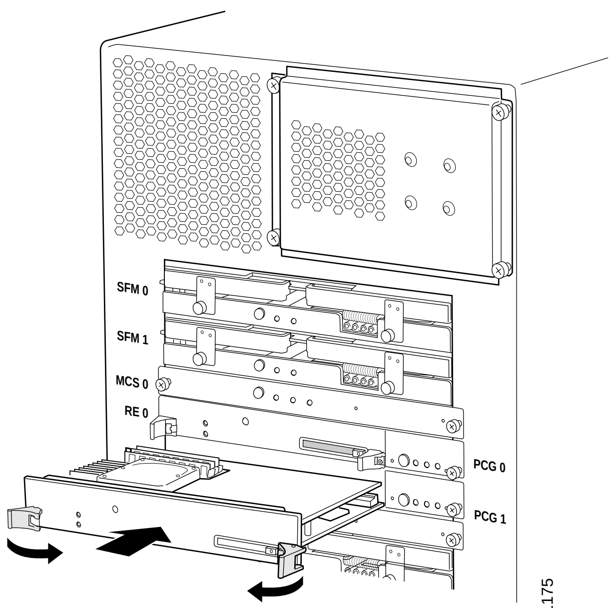
> **Caution**
>
> When replacing the Routing Engine, slide the unit in evenly. If you push in one side ahead of the other, the unit could get lodged in the rail and become damaged.

5. Press the extractor clips on the left and right sides of the Routing Engine inward.

6. Tighten the screws on the extractor clips.

7. To reinstall the second Routing Engine, repeat Steps 2 through 6.

Figure 55: Reinstall a Routing Engine



Reinstall the PCGs

To reinstall the PCGs into the rear of the chassis in the slots marked PCG0 and PCG1, use the following procedure (see Figure 56):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Hold the PCG by placing one hand under the unit to support it and grasping the mounting screw on the PCG faceplate with the other hand.

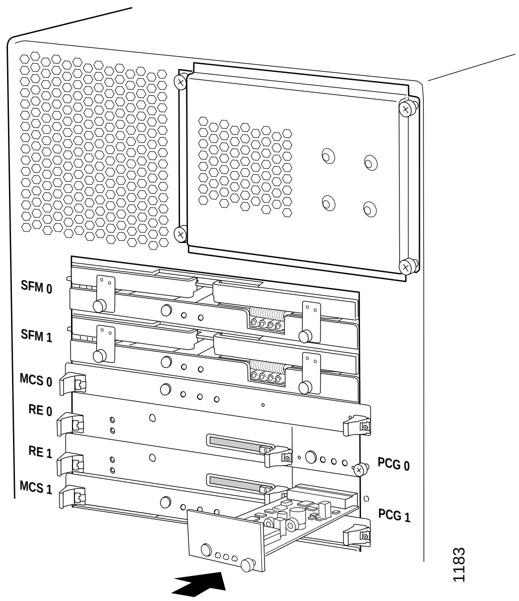
3. Align the rear of the PCG with the guides inside the chassis.

4. Slide the PCG completely into the chassis.

5. Tighten the mounting screw on the PCG faceplate.

6. To reinstall the second PCG, repeat Steps 2 through 5.

Figure 56: Reinstall a PCG



Reinstall the MCS

To reinstall the MCS into the rear of the chassis, use the following procedure (see Figure 57):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Hold the MCS by placing one hand underneath to support it and the other hand on one of the ejector handles on the faceplate.

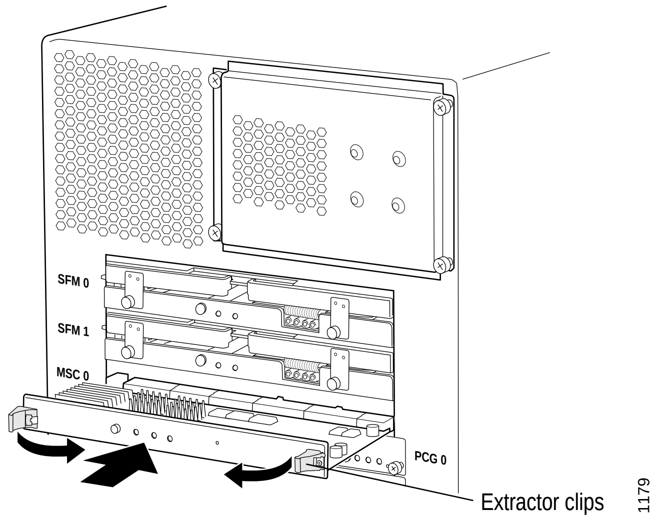
3. Align the rear of the unit with the guides inside the chassis.

4. Slide the unit completely into the chassis.

5. Press the extractor clips on the left and right sides of the MCS inward.

6. To reinstall the second MCS, repeat Steps 2 through 5.

Figure 57: Reinstall an MCS

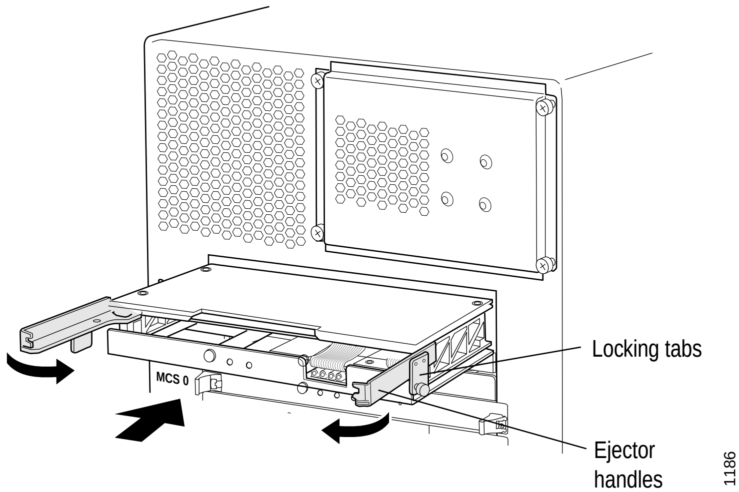


Reinstall the SFMs

To reinstall the SFMs into the rear of the chassis in the slots labeled SFM0 through SFM3, use the following procedure (see Figure 58):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Hold the SFM by placing one hand underneath to support it and the other hand on one of the ejector handles on the front of the unit.
3. Align the rear of the unit with the guides inside the chassis.
4. Slide the unit completely into the chassis.
5. Press the ejector handles on the left and right sides of the SFM inward.
6. Tighten the screws on the extractor clips.
7. Tighten the thumbscrews on the ejector locking tabs.
8. To reinstall the remaining SFMs, repeat Steps 2 through 7.

Figure 58: Reinstall an SFM



Reinstall the Rear Component Cover

After the SFMS, Routing Engine, MCS, and PCGs have been reinstalled, reinstall the rear component cover onto the back of the chassis, using the following procedure:

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Hold the component cover up to the rear of the chassis and align the flanges on the top and bottom with the top and bottom of the opening on the chassis.

3. Push the component cover into place.

4. Tighten the screws on the corners of the component cover.

Caution

Do not operate the router without the rear component cover being installed. The rear component cover must be in place to maintain proper airflow and provide electromagnetic shielding.

Reinstall the Power Supplies

To reinstall the power supplies into the power supply bays at the lower rear of the chassis, use the following procedure (see Figure 59):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

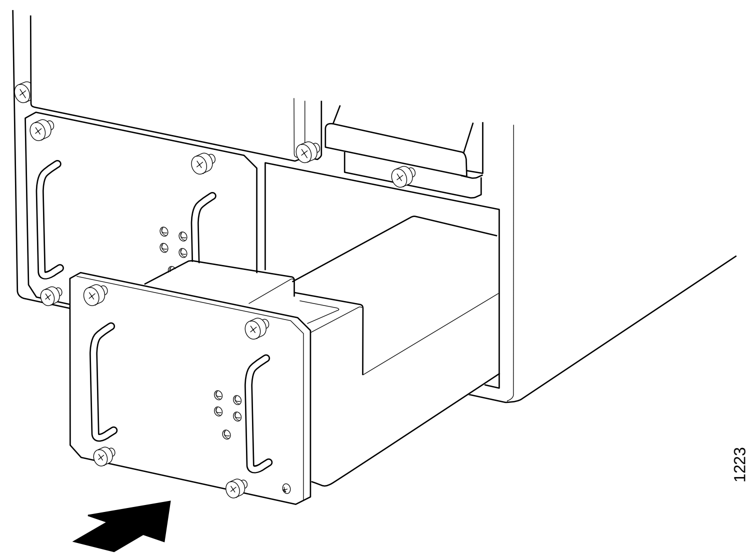
2. Verify that the circuit breakers on the router's on-board circuit breaker box are in the OFF position.

3. Using both hands, slide the power supply into the chassis until the power supply contacts the midplane (see Figure 59).

4. Starting with the bottom screws and working upward, tighten (but do not overtighten) the captive screws on the corners of the power supply faceplate.

5. To reinstall the second power supply, repeat Steps 2 through 4.

Figure 59: Reinstall a Power Supply



Connect the Router to External Devices

After you have installed the router into the rack, you connect external devices to the router to configure and manage the router and for service operations. Table 28 lists the cable specifications for each device.

Table 28: Routing Engine External Device Cable Specifications

Cable Type	Cable Specification	Supplied	Maximum Length	Connector Specification
Routing Engine console interface	RS-232 serial	One 6-foot length with DB-9/DB-9 connectors	6 ft. (1.83 m)	DB-9 female
Routing Engine auxiliary interface	RS-232 serial	No	6 ft. (1.83 m)	DB-9 female
Routing Engine Ethernet interface	Category 5 cable or equivalent suitable for 100BaseT operation	One 15-foot length with RJ-45/RJ-45 connectors	328 ft. (100 m)	RJ-45
Alarm card relay contacts	14–28 AWG wire	No	—	None

To connect external devices, use the following procedures:

- Connect a Management Console on page 146
- Connect an Auxiliary Device on page 147
- Connect to a Network for Out-of-Band Management on page 147
- Connect Alarm Relay Cables on page 148

Connect a Management Console

You can use a console to configure and manage the router. To connect a console to the router, use the following procedure:

1. Locate the appropriate cable and connector (see Figure 60 and Table 28).
2. Turn off the console power switch.
3. Plug the female end of the console cable connector into the CONSOLE port on the CIP (see Figure 61).
4. Tighten the screws on the connector.

Figure 60: Console and Auxiliary Serial Port Connector

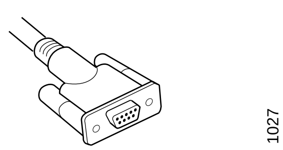
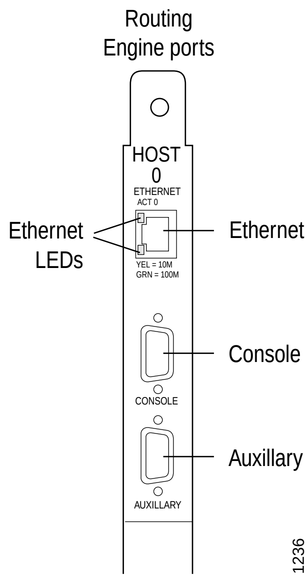


Figure 61: Routing Engine Ports on the CIP



Connect an Auxiliary Device

You can connect a modem, laptop, or other auxiliary device to the router. To connect the auxiliary device use the AUXILIARY serial port, use the following procedure:

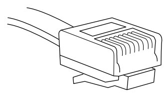
1. Locate the appropriate cable and connector (see Figure 60 and Table 28).
2. Turn off the auxiliary device power switch.
3. Plug the female end of the auxiliary device cable connector into the AUXILIARY port on the CIP (see Figure 61).
4. Tighten the screws on the connector.

Connect to a Network for Out-of-Band Management

You can connect the router to a network for out-of-band management. To connect the system to a network, use the following procedure:

1. Locate the appropriate cable and connector (see Figure 62 and Table 28).
2. Plug one of the Ethernet cable connectors into the ETHERNET port on the CIP.
3. Plug the other end into the network device.

Figure 62: Routing Engine Ethernet Cable Connector



Connect Alarm Relay Cables

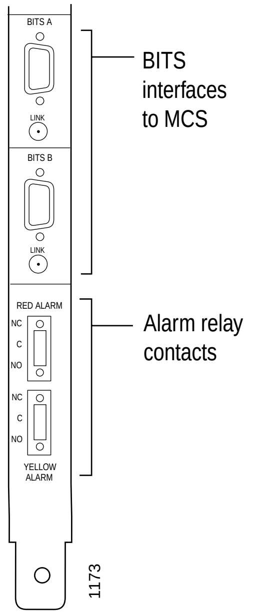
You can connect the router to an external alarm device so that conditions initiating a red or yellow alarm also trigger an external alarm device. Two alarm relay contacts are located on the CIP. The upper alarm relay contact is triggered by a red alarm condition and the lower one is triggered by a yellow alarm condition.

The terminal blocks that plug into the alarm relay contacts are supplied with the router. They accept wire of any gauge between 24-AWG and 12-AWG (0.20 and 3.33 mm^2). Use the gauge of wire appropriate for the external device that you are connecting to the terminal block.

To connect alarm relay contact cables, use the following procedure (see Figure 63):

1. Locate and prepare an appropriate length of wire that can be used with the external alarm device.
2. While the terminal block is not plugged into the relay contact, use a 2.5 mm flat-blade screwdriver to loosen the small screws on its side. Insert wires into the slots in the front of the block. Tighten the screws to secure the wire.
3. Select the appropriate relay contact—the upper contact for a device that reports high priority (red) alarms, or the lower contact for the device that reports lower priority (yellow) alarms.
4. Orient the terminal block according to the labels to the left of the chosen relay contact (NC means “normally closed,” C means “common,” and NO means “normally open”).
5. Plug the terminal block into the relay contact and use a 2.5 mm flat-blade screwdriver to tighten the screws on the face of the block.
6. Attach the other end of the wire to the external device.
7. To attach an external device for the other kind of alarm, repeat Steps 1 through 6 for the second terminal block.

Figure 63: Alarm Relay Contacts on the CIP



Connect the PIC Cables

To connect the PIC cables into the cable connectors on the front of the PICs, use the following procedure (see Figure 64):

1. Identify the appropriate cable to be connected to each PIC (see Table 29).

> **Warning**
>
> Do not look directly into PICs that are attached to an FPC. PICs that use SONET/SDH or ATM single-mode optical fiber contain laser light sources that can damage your eyes.

2. When installing PICs with optical interfaces, remove the rubber safety plug from the cable receptacle.

3. Insert the appropriate cable connector into the PIC cable receptacle.

4. Drape cable over the struts of the cable management system at the lower front of the chassis to prevent cables from dislodging or developing stress points. Secure the fiber so that it is not supporting its own weight as it dangles to the floor. Place excess fiber out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.

> **Caution**
>
> Never let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, because this stresses the cable at the fastening point.

Figure 64: Attach Cable to a PIC

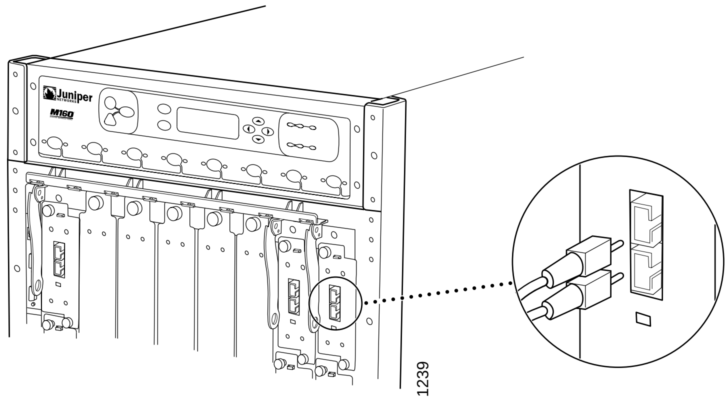


Table 29: PIC Cable Specifications

Cable Type	Cable Specification	Supplied	Maximum Length	Connector Specification
Single-mode interface (fiber)	SC-SC duplex	No	Short reach: 1.25 miles (2 km)	SC
			Intermediate reach: 9.3 miles (15 km)	SC
Multimode interface (fiber)	SC-SC duplex	No	1.25 miles (2 km)	SC

Connect Power to the Router

You connect power to the router by attaching power cables from the DC power sources to the terminal studs on the router's onboard circuit breaker box. To connect power to the router, you must provide power and grounding cables with appropriate cable lugs. For power and grounding cable specifications, see "Power and Grounding Cable Specifications" on page 61.

To connect the DC power cabling to the circuit breaker box, use the following procedure:

1. Ensure that the voltage across the DC power source cable leads that you are connecting to the circuit breaker box is 0 V and that there is no chance that the cable leads might become active during installation.

   Caution There is no color code standard for the DC wiring. The color coding used by the site DC power source determines the color coding of the DC power cable leads to the circuit breaker box. You must ensure that the proper polarity is connected to the circuit breaker box. The power source DC cables might be marked with a (+) or a (–) label, indicating the cable polarity.

2. Place the grounding cable lug over the grounding points on the right rear of the chassis. The grounding cable should already be attached to a proper earth ground for both DC power sources.

3. Secure the grounding cable lug to the grounding points, first with the washer, then with the bolt.

4. Remove the clear cover from the circuit breaker box.

5. Attach the power cable lugs for both power sources to the terminal studs on the circuit breaker box (see Figure 65).

   - Connect the positive (+) source DC power cable lugs to the RTN (return) terminals on the circuit breaker box.

   - Connect the negative (–) source DC power cable lugs to the –48V (input) terminals on the circuit breaker box.

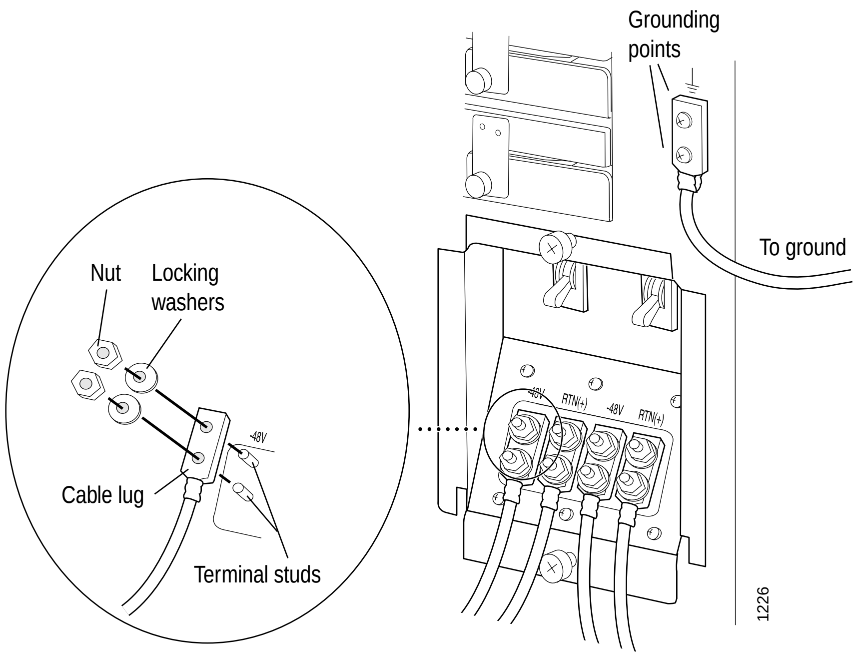
   Note The router must be connected to two DC power sources, one for each circuit breaker.

6. Secure the power cable lugs to the terminal studs, first with the washer, then with the nut.

7. Make certain that the positive (+) source DC power cable lug is connected to the RTN (return) terminal on the router's on-board circuit breaker box, and that the negative (–) power cable lug is connected to the –48V (input) terminal on the circuit breaker box.

8. Replace the clear cover.

Figure 65: Connect Power to the Circuit Breaker Box



Power Up the Router

To power up the router, follow this procedure:

1. Make certain that the power supply is fully inserted in the chassis and that the captive screws are tightened.

2. Turn on the power to the management device that is connected to the Routing Engine through the CONSOLE or ETHERNET port.

3. Turn one circuit breaker on the circuit breaker box to the ON position and observe the LEDs on the power supply faceplate. If the power supply is correctly installed and is functioning properly, the CB ON LED lights steadily, the OUTPUT OK LED blinks briefly, then lights steadily, and the CB OFF and NO AIRFLOW LEDs (original power supply only) do not light.

4. Turn on the second circuit breaker and observe the LEDs on the second power supply faceplate. They also should follow the sequence described in Step 3.

> **Note**
>
> If the OUTPUT OK and CB ON LEDs do not light steadily, repeat the installation and cabling procedures described in “Reinstall the Power Supplies” on page 144 and “Connect Power to the Router” on page 151.

5. On the management device, monitor the startup process to verify that the system has booted properly.

Perform Initial Software Configuration

When you receive the router, the JUNOS Internet software is preinstalled and is ready to be configured when the router is powered on. The primary copy of the software is installed on a nonrotating flash disk, and two backup copies are included: one on the router's rotating hard disk and a second on a PC card that ships with the router. When the router boots, it first attempts to start the image from a PC card if one is installed in the Routing Engine. If this fails, the router next tries the flash disk, then finally the hard disk.

You can configure the router from a console attached to the CONSOLE port on the CIP, or by using telnet over a network connected to the ETHERNET port. Before you configure the router, you need the following information:

- Name the router will use on the network
- Domain name the router will use
- IP address and prefix length information for the Ethernet interface
- IP address of a default router
- IP address of a DNS server
- Password for the root user

To configure the software, follow this procedure:

1. Power up the router as described in "Power Up the Router" on page 152.

2. Log in as the "root" user. There is no password.

3. Start the CLI.

    root# **cli**
    root@>

4. Enter configuration mode.

    cli> **configure**
    [edit]
    root@#

5. Configure the name of the router. If the name includes spaces, enclose the name in quotation marks (" ").

    [edit]
    root@# **set system host-name** *host-name*

6. Configure the router's domain name.

    [edit]
    root@# **set system domain-name** *domain-name*

7. Configure the IP address and prefix length for the router's Ethernet interface.

    [edit]
    root@# **set interfaces fxp0 unit 0 family inet address** *address/prefix-length*

8. Configure the IP address of a backup router, which is used only while the routing protocol is not running.

```
[edit]
root@# set system backup-router address
```

9. Configure the IP address of a DNS server.

```
[edit]
root@# set system name-server address
```

10. Set the root authentication password by entering either a clear-text password, an encrypted password, or an ssh public key string (DSA or RSA).

```
[edit]
root@# set system root-authentication plain-text-password
New password: password
Retype new password: password
or
[edit]
root@# set system root-authentication encrypted-password encrypted-password
or
[edit]
root@# set system root-authentication ssh-dsa public-key
or
[edit]
root@# set system root-authentication ssh-rsa public-key
```

11. Optionally, display the configuration to verify that it is correct.

```
[edit]
root@# show
system {
   host-name host-name;
   domain-name domain-name;
   backup-router address;
   root-authentication {
      authentication-method (password | public-key);
   }
   name-server {
      address;
   }
}
interfaces {
    fxp0 {
      unit 0 {
         family inet {
            address address/prefix-length;
         }
      }
   }
}
```

12. Commit the configuration. This activates the configuration on the router.

```
[edit]
root@# commit
```

13. Optionally, configure additional properties by adding the necessary configuration statements. Then, commit the changes to activate them on the router.

    [edit]
    root@*host-name*# **commit**

14. When you have finished configuring the router, exit configuration mode.

    [edit]
    root@*host-name*# **exit**
    root@*host-name*>

The router is now connected to the network but is not fully configured. You must perform additional configuration before the router can pass traffic. For complete information about configuring the router, including examples, see the JUNOS Internet software configuration guides.

Part 3
Hardware Maintenance and Replacement Procedures

Chapter 9
Hardware Maintenance Overview

This chapter provides general guidelines and procedures for maintaining the router. The chapter discusses the following topics:

- Routine Maintenance Procedures on page 159
- Replacing FRUs on page 160
- Returning Parts for Repair or Replacement on page 160

The remaining chapters in this section describe how to maintain and replace the individual router components.

Routine Maintenance Procedures

This section provides the following guidelines for routine preventive maintenance of the router:

- Inspect the Installation Site on page 159
- Check System Status with the Craft Interface on page 159
- Maintain the Air Filter on page 160

Inspect the Installation Site

Routinely inspect the installation site for potential problems caused by moisture, loose wires, and excessive dust. Make sure that the router has an unobstructed air flow. Also, routinely review and follow the other guidelines in this chapter.

Check System Status with the Craft Interface

Use the craft interface to routinely check the status of the router. The craft interface contains system alarms, system LEDs, and an LCD display to inform you of potential problems. For a complete description of the craft interface, see “Craft Interface” on page 23.

Maintain the Air Filter

It is particularly important to keep the air filter in place in the router. Routinely inspect the air filter and clean or replace it as needed so that the cooling system can function optimally. For instructions, see “Maintain the Air Filter” on page 175.

Replacing FRUs

To replace a FRU, you must first contact your sales representative to order the FRU.

The following chapters provide procedures for removing and replacing FRUs in the router. For a description of the FRUs for this router, see “Field-Replaceable Units (FRUs)” on page 4.

Returning Parts for Repair or Replacement

For information about returning a part for repair or replacement, see “Return the Router or Its Components” on page 249.

Chapter 10
Maintain and Replace Power System Components

This chapter discusses the following topics related to maintaining and replacing the power system components:

- Tools and Parts Required on page 161
- Maintain the Power Supplies on page 162
- Replace a Power Supply on page 162
- Disconnect and Connect DC Power on page 165
- Replace the Circuit Breaker Box on page 168
- Maintain the Fuses on page 171
- Replace a Fuse on page 173

Tools and Parts Required

To maintain and replace the power supplies and connect power to the router, you need the following tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- ESD grounding wrist strap
- Wire cutters
- 7/16 in. nut driver or pliers
- Replacement fuse

Maintain the Power Supplies

To maintain the power supplies, follow these guidelines:

- Make sure that the power and grounding cables are arranged so that they do not obstruct access to other router components.
- Routinely check the LEDs on the power supply faceplate—The blue OUTPUT OK LED indicates that the power supply is functioning normally, and the amber CB OFF LED indicates a power supply failure. For more information about the power supply LEDs, refer to "Prepare the Site" on page 53.
- Routinely check the red alarm LED on the craft interface—A red alarm condition can be caused by a power supply failure. Immediately check the source of an alarm condition by using the LCD menu system, which is described in "Craft Interface" on page 23.
- The power supplies require an unobstructed air flow at both front and rear of the chassis—Periodically check the site to ensure that both the air intake at the bottom front of the chassis and the exhaust at the rear of the chassis are unobstructed.
- Periodically inspect the site to ensure that the grounding and other cables connected to the router are securely in place and that there is no moisture accumulating near the router—To review system grounding and site wiring requirements, see "Prepare the Site" on page 53.
- To check the status of the power supplies, use the following CLI command:

  ```
  user@host> show chassis environment pem
  ```

  For more information about using the CLI to get information, see the *JUNOS Internet software manuals*.

Replace a Power Supply

The router has two load-sharing, redundant DC power supplies. Each power supply is hot-removable and hot-insertable. Before removing a power supply, you must make sure that the power switch on the corresponding router's onboard circuit breaker box is in the OFF position. When one power supply is powered down, the other power supply automatically assumes the entire electrical load for the system.

To replace a power supply, use the following procedures:

- Remove a Power Supply on page 163
- Install a Power Supply on page 164
- Verify That the Power Supply Is Installed Correctly on page 165

Remove a Power Supply

The power supplies are located at the bottom rear of the chassis. Each power supply weighs approximately 13 lbs (5.9 kg).

Caution	Do not leave the power supply slot in the chassis empty for more than two minutes while the router is operational. The power supply must remain in the chassis to provide correct airflow.

To remove a power supply, follow this procedure (see Figure 66):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Turn the circuit breaker on the router's onboard circuit breaker box corresponding to the power supply to the OFF position.

3. Loosen the thumbscrews on the corners of the power supply faceplate.

Warning	Do not touch the power connectors on the back side of the power supply (see Figure 67). They could contain dangerous voltages.

Note	You will probably need a screwdriver to loosen the thumbscrews.

4. Grasp the handles on the power supply faceplate, pull firmly to start the power supply out of the chassis, and slide it halfway out of the chassis.

5. Place one hand under the power supply to support it, and slide it completely out of the chassis.

Figure 66: Remove a Power Supply

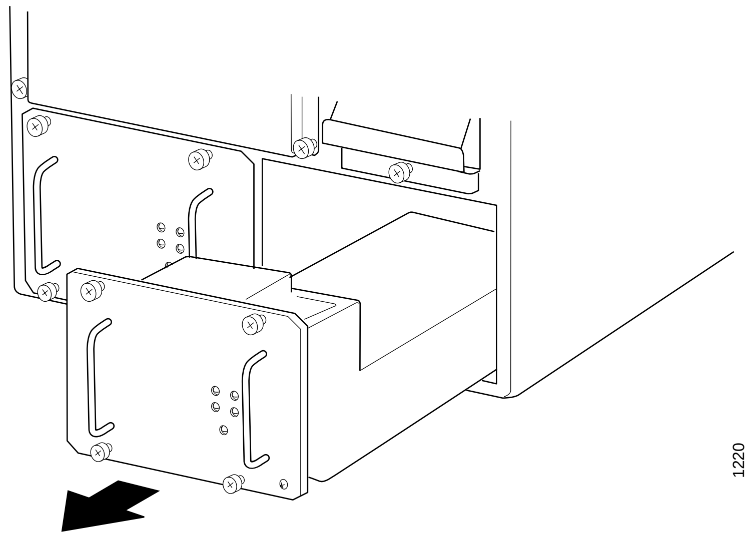
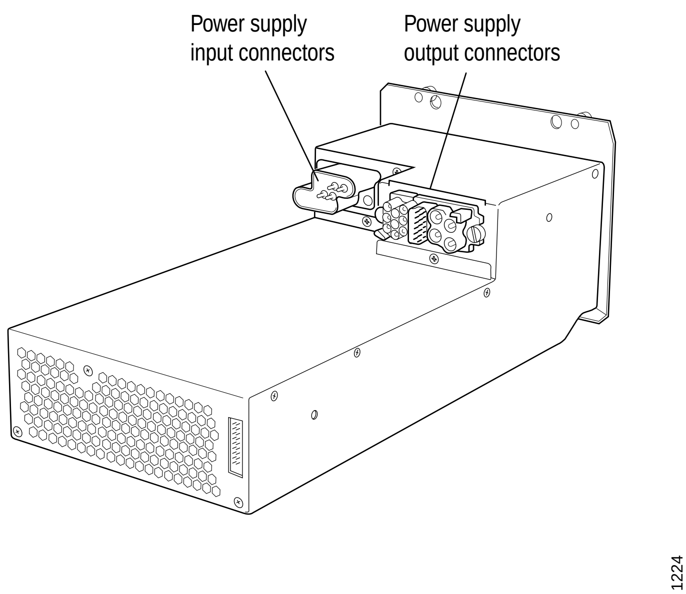


Figure 67: Rear of Power Supply Showing Midplane Connectors



Install a Power Supply

To install a power supply, follow this procedure:

1. Remove the replacement power supply from its shipping container.

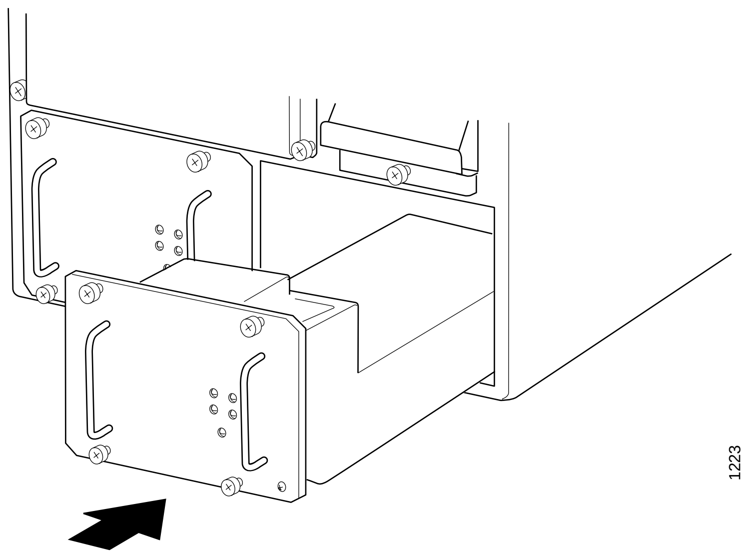
2. Verify that the circuit breaker on the router's onboard circuit breaker box is in the OFF position.

3. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

4. Using both hands, slide the power supply into the chassis until it contacts the midplane.

5. Starting with the bottom screws, tighten the thumbscrews on the corners of the power supply faceplate.

Figure 68: Install a Power Supply



Verify That the Power Supply Is Installed Correctly

To verify that the power supply is installed correctly, turn the circuit breaker corresponding to the power supply to the ON position. If the power supply is functioning normally, the green CB ON LED on the power supply faceplate lights steadily and the blue OUTPUT OK LED blinks momentarily, then lights steadily.

Disconnect and Connect DC Power

The DC power cables connect to a circuit breaker box on the lower right side of the chassis. The circuit breaker box contains the circuit breakers for the power supplies and the terminal studs to connect external DC source power to the router.

To connect DC power to the router, use the following procedures:

- Disconnect Power to the Router on page 166
- Connect Power to the Router on page 167

Disconnect Power to the Router

To disconnect the DC power cables from the circuit breaker box, follow this procedure:

1. Ensure the voltage across the DC power source cable leads connected to the circuit breaker box is 0 V and that there is no chance that the cables might become active during the disconnection process.

> **Caution**
>
> There is no color code standard for the DC wiring. The color coding used by the site DC power source determines the color coding of the DC power cable leads to the circuit breaker box. You must ensure that the proper polarity is connected to the circuit breaker box. The power source DC cables might be marked with a (+) or a (–) label, indicating the cable polarity.

2. Turn the circuit breaker corresponding to the power supply you want to remove to the OFF position.
3. Remove the clear cover from the circuit breaker box.
4. Loosen the nuts securing the cable lugs to the terminal studs on the circuit breaker box (see Figure 69 on page 168).
5. Remove the nut and washer from each terminal stud.
6. Remove the cable lugs from the terminal studs.
7. Unscrew the bolts fastening the grounding lug to the chassis.

> **Caution**
>
> To prevent electrical hazards, disconnect the power cables before disconnecting the grounding cable.

8. Remove the grounding lug from the chassis.
9. Replace the clear cover.

   Be sure that the cables are not touching or in the way of any system components.

Connect Power to the Router

Before you connect power to the router's onboard circuit breaker box, you must have the proper power and grounding cables with appropriate cable lugs. For power and grounding cable specifications, see "Power and Grounding Cable Specifications" on page 61.

To connect the DC power cabling to the circuit breaker box, follow this procedure (see Figure 69):

1. Ensure the voltage across the DC power source cable leads that you will connect to the circuit breaker box is 0 V and that there is no chance that the cable leads might become active during installation.

> **Caution**: There is no color code standard for the DC wiring. The color coding used by the site DC power source determines the color coding of the DC power cable leads to the circuit breaker box. You must ensure that the proper polarity is connected to the circuit breaker box. The power source DC cables might be marked with a (+) or a (–) label, indicating the cable polarity.

2. Place the grounding cable lug over the grounding points on the right rear of the chassis. The grounding cable should already be attached to a proper earth ground for both DC power sources.

3. Secure the grounding cable lug to the grounding points, first with the washers, then with the bolts.

> **Caution**: Be sure the ground is connected before connecting the power cables to the circuit breaker box.

4. Remove the clear cover from the circuit breaker box.

5. Attach the power cable lugs for both power sources to the terminal studs on the circuit breaker box (see Figure 69). For each set of terminal studs:

   - Connect the positive (+) source DC power cable lug to the RTN (return) terminal on the circuit breaker box.

   - Connect the negative (–) source DC power cable lug to the –48V (input) terminal on the circuit breaker box.

> **Caution**: The router must be connected to two dedicated DC power sources, one for each circuit breaker.

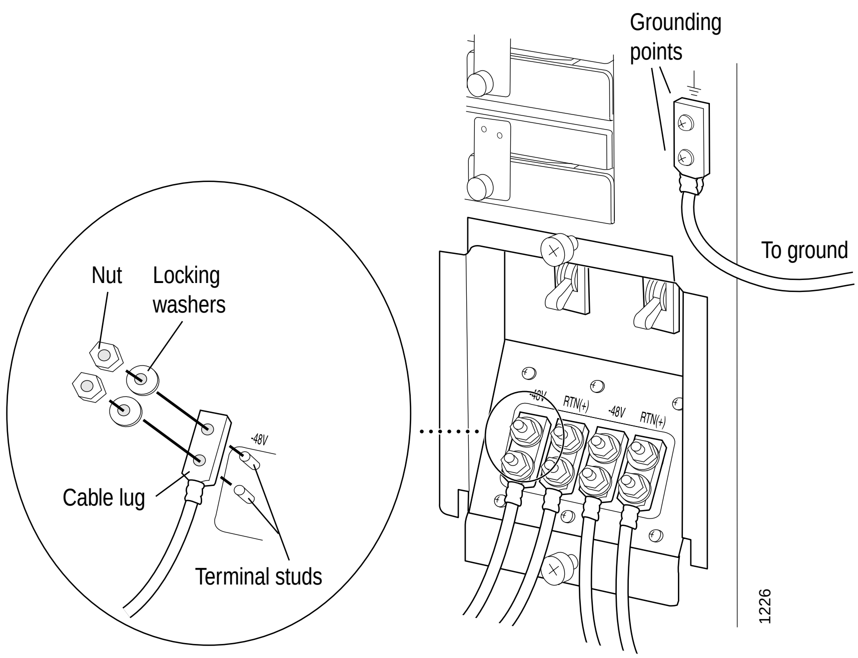
Be sure that the cables are not touching or in the way of any system components.

6. Secure the power cable lugs to the terminal studs, first with the washers, then with the nuts.

7. Verify that the DC source power cabling and the grounding cabling are correct.

8. Replace the clear cover.

Figure 69: Connect Power to the Circuit Breaker Box



Replace the Circuit Breaker Box

The router has a circuit breaker box, which is located on the rear of the chassis above the right power supply. The circuit breaker box provides two circuit breakers, one for each power supply. The circuit breaker box is field-replaceable, but is not hot-removable, hot-insertable, or hot-pluggable. You must power down the router before removing or replacing it.

To replace the circuit breaker box, use the following procedures:

- Remove the Circuit Breaker Box on page 169
- Install the Circuit Breaker Box on page 170
- Verify That the Circuit Breaker Box Is Installed Correctly on page 171

Remove the Circuit Breaker Box

The circuit breaker box is located on the rear of the chassis above the right power supply. It weights about 6 lbs (2.7 kg).

To remove the circuit breaker box, follow this procedure (see Figure 70):

1. On the management device connected to the router, enter CLI operational mode and issue the following command to shut down the router. For more information, see the *JUNOS Internet Software Operational Mode Command Reference*.

   user@host> **request system halt**

   Wait to continue until all software processes shut down.

2. Ensure the voltage across the DC power source cable leads that you will connect to the circuit breaker box is 0 V and that there is no chance that the cable leads might become active during removal or installation.

3. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

4. Turn both the switches on the circuit breaker box to the OFF position.

5. Remove the rear lower impeller assembly by loosening the captive screws on the corners of the impeller cover and pulling the impeller assembly straight out from the chassis.

6. Remove the clear cover from the circuit breaker box.

7. Unscrew the nuts holding the power cable lugs onto the terminal studs on the circuit breaker box. Remove the nuts and the washers from each cable lug.

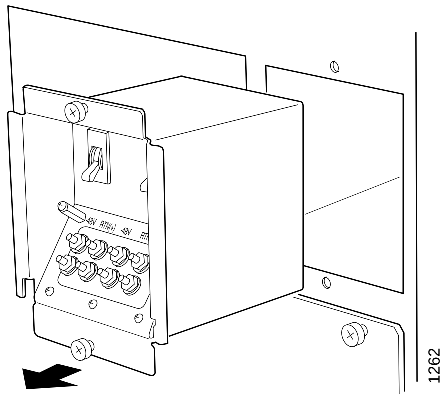
> **Caution**
>
> Do not remove the grounding lugs from the grounding points on the chassis.

8. Pull the power cable lugs off the studs.

9. Unscrew the two thumbscrews on the top and bottom edges of the circuit breaker box.

10. Pull the circuit breaker box straight out from the chassis.

Figure 70: Remove the Circuit Breaker Box



Install the Circuit Breaker Box

To install the circuit breaker box, follow this procedure (see Figure 71):

1. Ensure the voltage across the DC power source cable leads that you will connect to the circuit breaker box is 0 V and that there is no chance that the cable leads might become active during installation.

2. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

3. Push the circuit breaker box straight into the chassis. Be careful to align the guide pin on the back of the circuit breaker box with the hole inside the chassis (see Figure 71).

4. Screw the two thumbscrews on the top and bottom edges of the circuit breaker box.

5. Screw the four screws into the corners of the circuit breaker box.

6. Attach the power cable lugs to the terminal studs on the circuit breaker box, and secure them, first with the washers and then with the nuts.

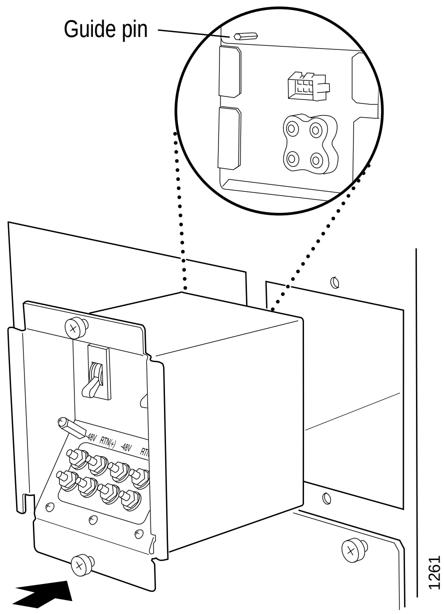
7. Replace the clear cover on the circuit breaker box.

8. Replace the rear lower impeller assembly by lining up the rails with the guides inside the chassis and pushing the impeller straight into the chassis. Tighten the captive screws on the corners of the impeller cover.

9. Apply voltage from the DC power sources to the power cables so the router receives power.

10. Turn the switches on the circuit breaker box to the ON position.

Figure 71: Install the Circuit Breaker Box



Verify That the Circuit Breaker Box Is Installed Correctly

If the circuit breaker box is installed and power connected to the router correctly, the lights on the power supplies will go through their startup sequence when the switches on the circuit breaker box are turned to the ON position. The CB ON LED lights steadily, the OUTPUT OK LED blinks briefly, then lights steadily, and the CB OFF and NO AIRFLOW LEDs do not light.

Maintain the Fuses

The router uses Cooper Bussman brand GMT-type fuses for the FPCs, SFMs, MCSs, and PCGs. They are located in a fuse box on the rear of the midplane. When the fuse for a component blows, the component stops functioning even though it is installed correctly and the power supplies are still providing power to the router.

Figure 72 shows the location of the fuse for each component. The fuse locations are also shown on a table attached to the midplane below the fuses. The labels shown in the figure do not appear on the actual fuses (the clear cover on every fuse reads BUSS GMT-X), but a table on the surface of the midplane below the fuse box displays the same information.

To maintain the fuses, follow these guidelines:

- Whenever a component's LED fails to light, check to see if the fuse for that component is blown.
- If the CLI indicates that the component is present but is not receiving power, check to see if the fuse for that component is blown.

- Check the amber LED next to each fuse. For vertically oriented fuses (in the groups labeled J241 through J244 in Figure 72), the LED is located below the fuse; for horizontally oriented fuses (in the group labeled J240), it is to the left of the fuse.
- In a fuse that has blown, the colored indicator bulb becomes visible through the clear cover on the fuse. Table 30 specifies the indicator bulb color for each fuse type, along with corresponding component, fuse rating, quantity, and location in the fuse box.

Table 30 lists fuse power ratings and specifications.

Figure 72: Fuse Locations on the Midplane

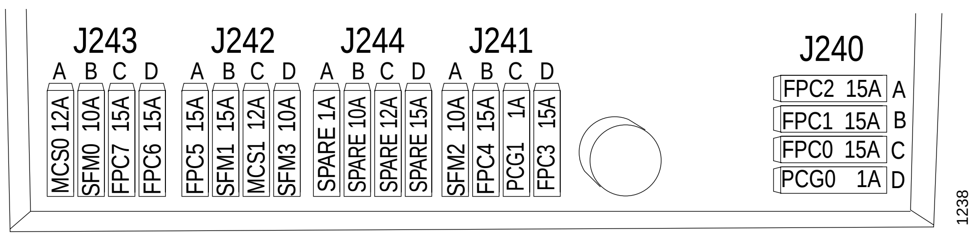


Table 30: Fuse Specifications

Description	Rating	Color	Quantity	Locations
FPC	15 A	Red and blue	9	J240 A, B, and C J241 B and D J242 A J243 C and D J244 D (spare)
MCS	12 A	Yellow and green	3	J242 C J243 A J244 C (spare)
SFM	10 A	Red and white	5	J241 A J242 B and D J243 B J244 B (spare)
PCG	1 A	Gray	3	J240 D J241 C J244 A (spare)

Replace a Fuse

The router uses Cooper Bussman brand GMT-type fuses with the ratings shown in Table 30. Replacement fuses can be ordered as GMT-*x*, where *x* is the amperage rating of the fuse.

To replace a fuse, follow this procedure:

1. Attach an ESD strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Remove the rear lower impeller assembly by loosening the thumbscrews on the corners of the impeller cover and sliding the impeller assembly out of the chassis.
3. Identify the blown fuse using the yellow LEDs next to the fuses.
4. Grasp the clear plastic cover of the fuse by the edges and rock it back and forth to loosen the fuse. If the cover slips off the fuse, snap the cover back into place.
5. Take the correct rating (see Table 30 for fuse ratings) from the set of fuses marked SPARE (in the area labeled as J244 in Figure 72). Positively match both the color coding and the labeled rating of the blown fuse before replacing the fuse.
6. Orient the fuse in the correct slot in the fuse box so that the text on the fuse cover reads from top to bottom (on vertically installed fuses) or from left to right (on horizontally installed fuses).
7. Press the new fuse into the slot.
8. Check that the yellow LED next to the replacement fuse is no longer lit.
9. After replacing the fuse, reinstall the rear lower impeller by sliding it back into the chassis and tightening the screws on the corners of the impeller cover.

Chapter 11
Maintain and Replace Cooling System Components

This chapter discusses the following topics related to maintaining and replacing the router cooling system components:

Tools and Parts Required

To replace cooling system components, you need the following tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- ESD grounding wrist strap

Maintain the Air Filter

The air filter is hot-removable and hot-insertable. However, you should not operate the router for more than a few minutes without the air filter in place, to avoid dust, particles, or other material being sucked into the router chassis.

The air filter should be checked regularly for dust and debris and cleaned or replaced as needed.

To maintain the air filter, use the following procedures:

- Remove the Air Filter on page 176
- Clean the Air Filter on page 177
- Install the Air Filter on page 177

Do not operate the router for more than a few minutes without the air filter in place. Because the impellers are very powerful, they could pull small bits of wire or other material into the router through an unfiltered air intake. This could damage some of the router components.

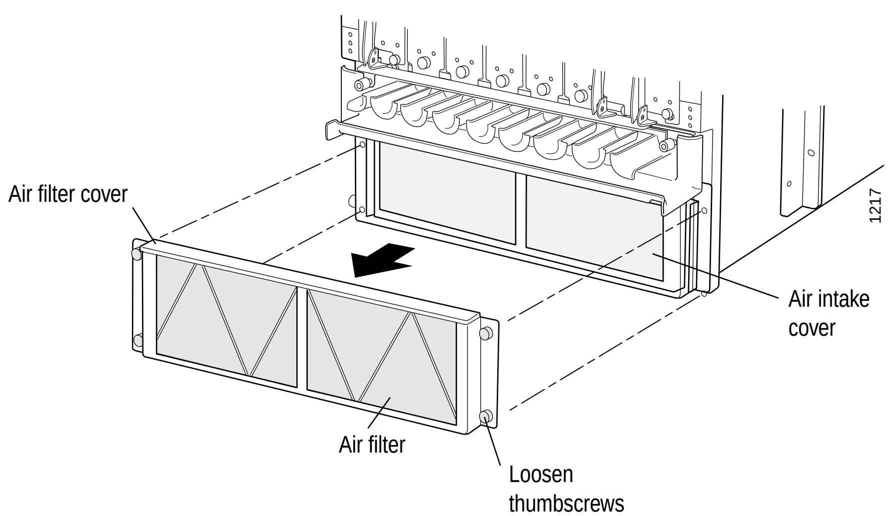
Remove the Air Filter

The air filter is located at the front of the chassis, below the FPC card cage.

To remove the air filter, follow this procedure (see Figure 73):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Loosen the thumbscrews on the corners of the air filter cover.
3. Grasp the edges of the air filter, and firmly pull it out from the chassis.
4. Inspect the filter for dust, dirt, and holes. If needed, clean the air filter as described in “Clean the Air Filter” on page 177 or replace the filter.

Figure 73: Remove the Air Filter



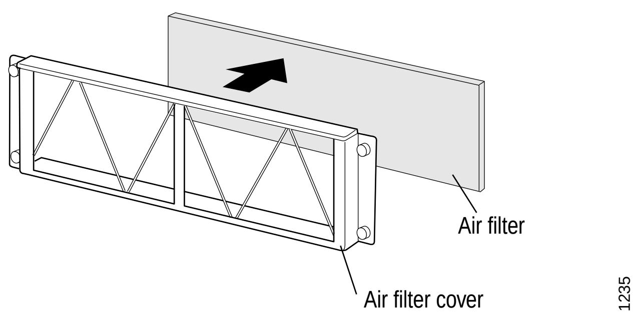
Clean the Air Filter

The air filter should be cleaned periodically.

To clean the air filter, follow this procedure:

1. Pull the filter free of the air filter cover (see Figure 74).
2. Rinse the filter with water, running the water from the back side to the front side to help remove dust and particles accumulated in the filter.
3. Allow the filter to dry completely.
4. Press the filter back into the air filter cover.

Figure 74: Remove the Filter from the Air Filter Cover

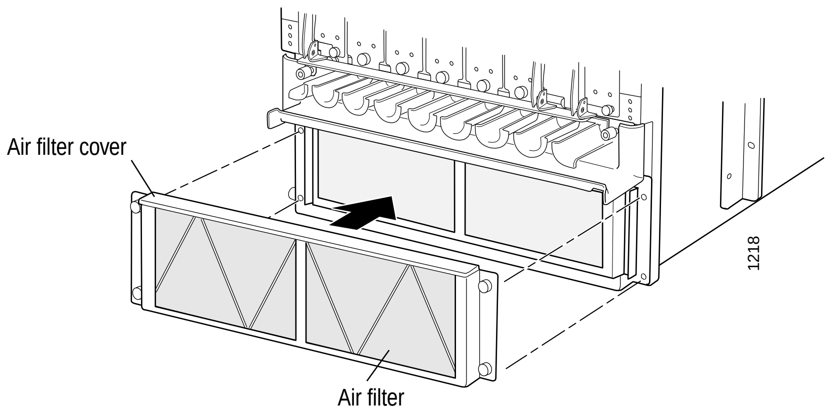


Install the Air Filter

To install the air filter, follow this procedure (see Figure 75):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Grasp the sides of the air filter and push it firmly into place over the air intake.
3. Tighten the thumbscrews on the corners of the air filter cover.

Figure 75: Install the Air Filter



Maintain the Fan Tray

The fan tray contains four fans that work in unison to cool the FPCs and the midplane. If one of the fans fails, the MCS adjusts the speed of the remaining fans to cool the FPCs and midplane indefinitely. A red alarm is triggered when a fan fails, and a yellow alarm is triggered when the fan tray is removed.

To display status information about the fans, use the following CLI command:

user@host> **show chassis environment**

For more information about using the command-line interface, see the JUNOS Internet software manuals.

Replace the Fan Tray

The router has one fan tray containing four fans. The fan tray, together with the cable management system, is hot-insertable and hot-removable.

Remove the Fan Tray

The fan tray is located below the FPC card cage. It is accessible from the lower front of the chassis, above the air filter. The fan tray weighs about 13 lbs (5.9 kg).

To remove the fan tray, follow this procedure:

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Detach the PIC cables from the cable management system and move away from the front of the router.

3. Loosen the thumbscrews on the faceplate of the fan tray.

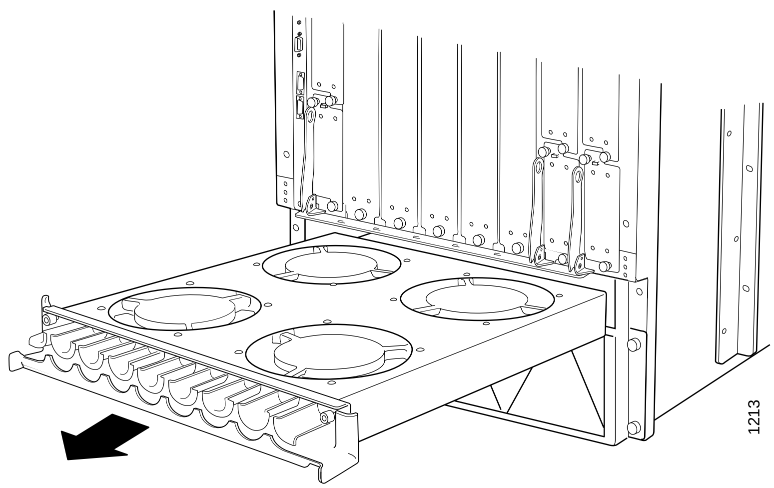
> **Note**
> You will probably need a screwdriver to loosen the thumbscrews.

4. Pull the fan tray, with the cable management system, halfway out of the chassis.

> **Caution**
> If the fans are still spinning, avoid putting your fingers or any tool into the fan tray as you pull it out. To avoid injury, wait until the fans stop spinning before removing the fan tray.

5. Pull the fan tray completely out of the chassis (see Figure).

Figure 76: Remove the Fan Tray



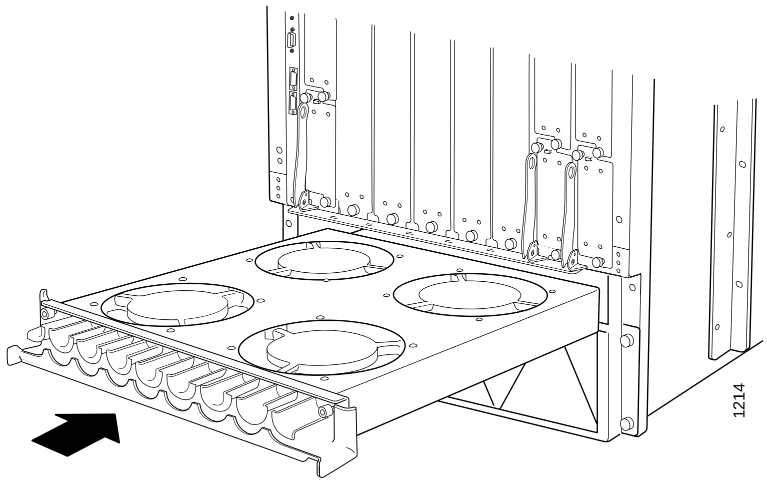
Install the Fan Tray

To install the fan tray, follow this procedure (see Figure 77):

1. Insert the replacement fan tray into the chassis and tighten the screws on the faceplate. The fans start functioning as soon as the fan tray contacts the midplane.

2. Reattach the PIC cables to the cable management system.

Figure 77: Install the Fan Tray



Maintain the Impellers

The router has three separate, non-interchangeable impeller assemblies. The front impeller works together with the fan tray to cool the FPCs and midplane, and the rear impellers work together to cool the components installed in the rear of the chassis.

Normally, the impellers and fans run at less than full speed. The following conditions automatically cause the fans and impellers to run at full speed:

- One of the impellers fails, triggering a red alarm.
- One of the fans or impellers is removed, triggering a yellow alarm.
- The temperature of the router exceeds the minimal threshold, triggering a yellow alarm.
- The temperature of the router exceeds the maximum threshold, triggering an automatic power supply shutdown and a red alarm.

To display status information about the impellers, use the following CLI command:

```
user@host> show chassis environment
```

For more information about using the command-line interface, see the *JUNOS Internet software manuals.*

Replace the Front Upper Impeller Assembly

The front upper impeller assembly is hot-removable and hot-insertable. To replace the front upper impeller assembly, use the following procedures:

- Remove the Front Upper Impeller Assembly on page 181
- Install the Front Upper Impeller Assembly on page 181

Remove the Front Upper Impeller Assembly

The front upper impeller assembly, together with the craft interface, is located above the FPC card cage. It is accessible from the front of the chassis. The front impeller assembly weighs about 14.5 lbs (6.6 kg).

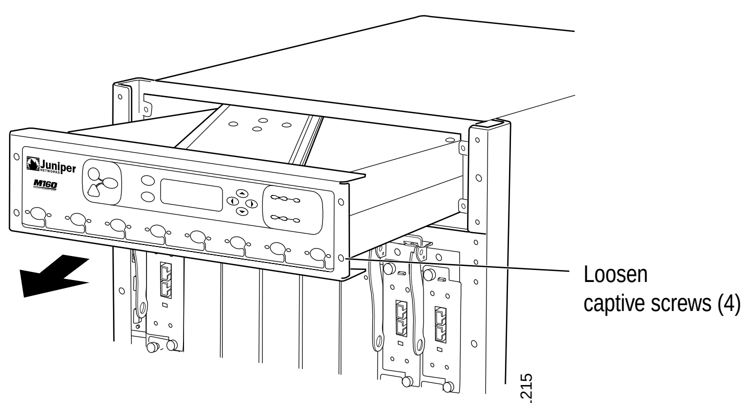
To remove the front upper impeller assembly, follow this procedure (see Figure 78):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Undo the captive screws at the corners of the impeller assembly (the craft interface).
3. Grasp the impeller assembly and pull it about halfway out of the chassis.

> **Caution**
>
> If the impeller is still spinning, do not put your fingers or any tool into the impeller assembly as you pull it out. To avoid injury, wait until the impeller stops spinning before removing the assembly.

4. Pull the impeller assembly completely out of the chassis.

Figure 78: Remove the Front Upper Impeller Assembly

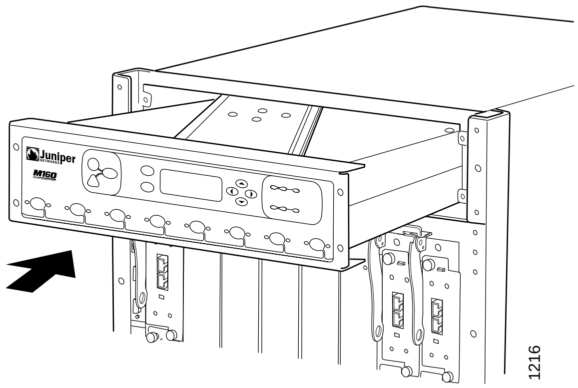


Install the Front Upper Impeller Assembly

To replace the front upper impeller assembly, follow this procedure (see Figure 79):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Slide the impeller assembly into the chassis.
3. Tighten the screws on the corners of the impeller cover.

Figure 79: Install the Front Upper Impeller Assembly



Replace the Rear Lower Impeller Assembly

The rear lower impeller assembly is hot-removable and hot-insertable. To replace the rear lower impeller assembly, use the following procedures:

- Remove the Rear Lower Impeller Assembly
- Install the Rear Lower Impeller Assembly

Remove the Rear Lower Impeller Assembly

The rear lower impeller assembly is located at the rear of the chassis, above the left power supply. It weighs about 5 lbs (2,3 kg).

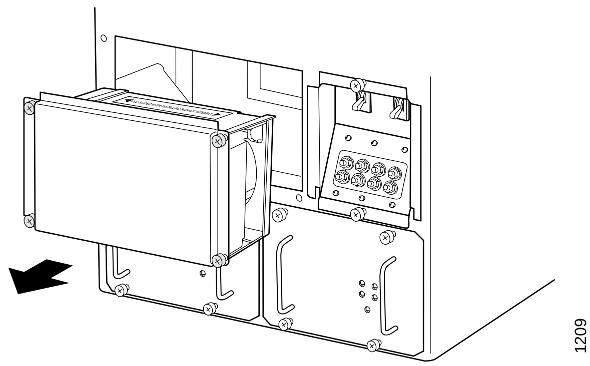
To remove the rear lower impeller assembly, follow this procedure (see Figure 80):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Undo the captive screws on the corners of the impeller cover.
3. Grasp the impeller assembly and pull it about halfway out of the chassis.

> **Caution**
>
> If the impeller is still spinning, do not put your fingers or any tool into the impeller assembly as you pull it out. To avoid injury, wait until the impeller stops spinning before removing it.

4. Pull the impeller assembly completely out of the chassis (see Figure 80).

Figure 80: Remove the Rear Lower Impeller Assembly

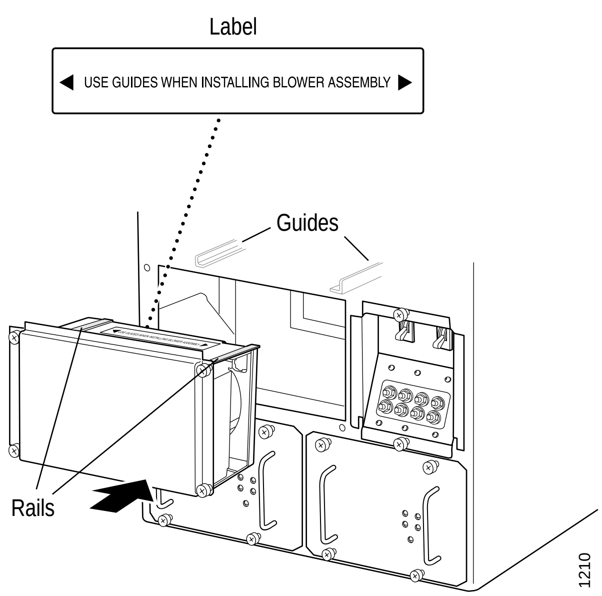


Install the Rear Lower Impeller Assembly

To install the rear lower impeller assembly, follow this procedure (see Figure 81):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Grasp the sides of the impeller assembly, and align the rails on top of the assembly with the guides inside the chassis.
3. Slide the impeller assembly all the way into the chassis.
4. Tighten the captive screws on the corners of the impeller cover.

Figure 81: Install the Rear Lower Impeller Assembly



Replace the Rear Upper Impeller Assembly

The rear upper impeller assembly is hot-removable and hot-insertable. To replace the rear upper impeller assembly, use the following procedures:

- Remove the Rear Upper Impeller Assembly
- Install the Rear Upper Impeller Assembly

Remove the Rear Upper Impeller Assembly

The rear upper impeller assembly is located in the upper left of the rear of the chassis. It weighs about 4 lbs (1.8 kg).

To remove the rear upper impeller tray, follow this procedure:

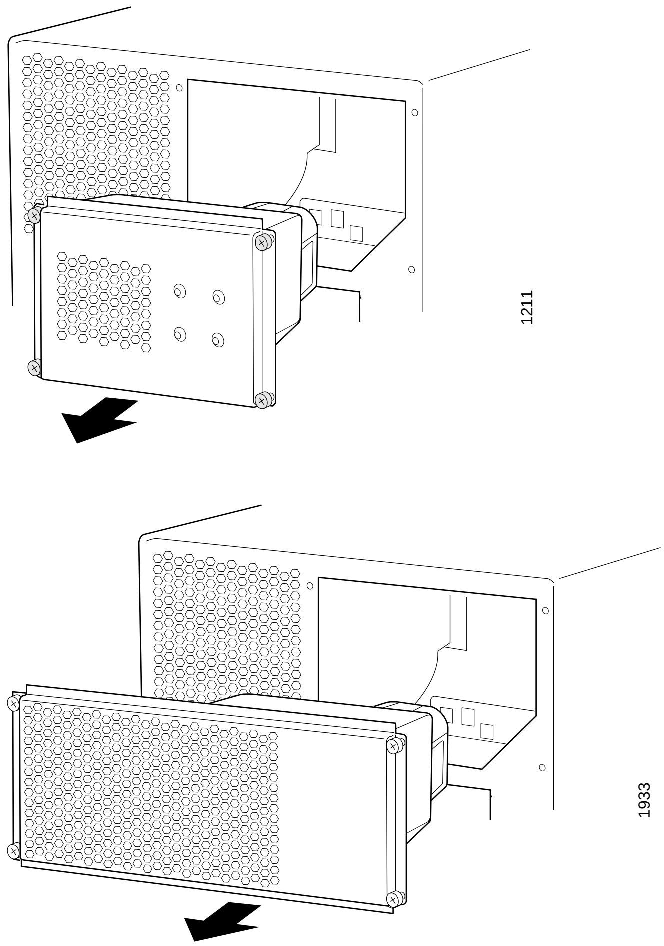
1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Loosen the captive screws on the corners of the impeller cover.
3. Grasp the impeller assembly and pull it about halfway out of the chassis.
4. Before removing the impeller tray, wait until the impellers stop spinning (about 45 seconds.).

> **Caution**
>
> If the impeller is still spinning, do not put your fingers or any tool into the impeller assembly as you pull it out. To avoid injury, wait until the impeller stops spinning before removing it.

5. Pull the impeller assembly completely out of the chassis (see Figure 80).

   There are two types of impeller assemblies, shown in Figure 82.

Figure 82: Remove the Rear Upper Impeller Assembly



Install the Rear Upper Impeller Assembly

To replace the rear upper impeller assembly, follow this procedure (see Figure 83):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

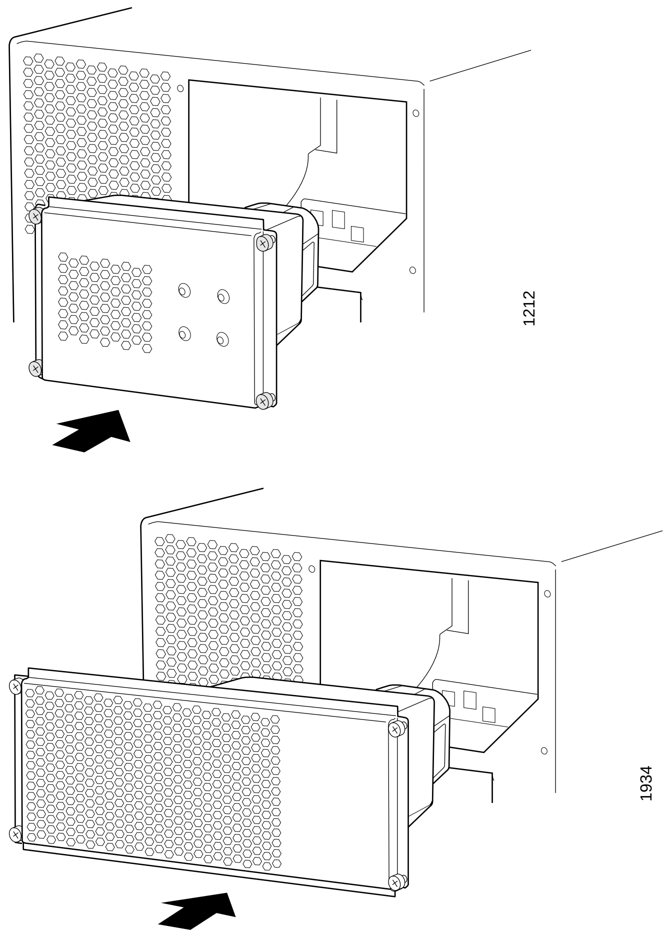
2. Grasp the sides of the impeller assembly, and align the rear of the tray with the rails inside the chassis.

3. Slide the impeller assembly all the way into the chassis.

4. Tighten the captive screws on the corners of the impeller cover.

   There are two types of impeller assemblies, shown in Figure 83.

Figure 83: Install the Rear Upper Impeller Assembly



Chapter 12

Maintain and Replace Packet Forwarding Engine Components

This chapter discusses the following topics related to maintaining and replacing the Packet Forwarding Engine components:

Tools and Parts Required

To replace Packet Forwarding Engine components, you need the following the tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- Electrostatic bags, one for each FPC and PIC removed
- An antistatic mat for each component that you are removing
- ESD grounding wrist strap
- Replacement components or blank panels for each component that you are removing
- A rubber safety cap to fit over PIC cable connectors for each PIC that you are removing

Maintain the FPCs and PICs

To maintain the FPCs and PICs, follow these guidelines:

- To observe the status of the FPCs, check the FPC LEDs and the LCD display on the craft interface. For more information, see “Craft Interface” on page 23.
- To display status information about installed FPCs and PICs, use the following command-line interface (CLI) command:

  user@host> **show chassis fpc**

  To display more detailed information, use the following option:

  user@host> **show chassis fpc detail**

- To observe the status of the PICs, check the PIC status LEDs. Each PIC has one LED located below the optical transceiver on the PIC faceplate. For information on the meanings of the PIC LEDs, see the *M160 Internet Router PIC Guide*.

  For more information about using the CLI, see the *JUNOS Internet Software Configuration Guide: Getting Started*.

> **Note**
>
> On SONET/SDH OC-12 interfaces, the REI-L and REI-P (SONET/SDH line and path remote error indication, also known as Line and Path FEBE) are not transmitted correctly in response to received bit errors. This could affect the accuracy of error statistics in the remote router, but has no effect on router's functionality. Received statistics are correctly accumulated.

Replace an FPC

The FPCs are hot-insertable and hot-removable. When you remove an FPC, the router continues to function, although the PIC interfaces installed on the FPC being removed no longer function. This section discusses the following topics:

Remove an FPC

The router can have up to eight FPCs, which are installed vertically in the front of the router. Each FPC weighs about 15 lbs (6.8 kg).

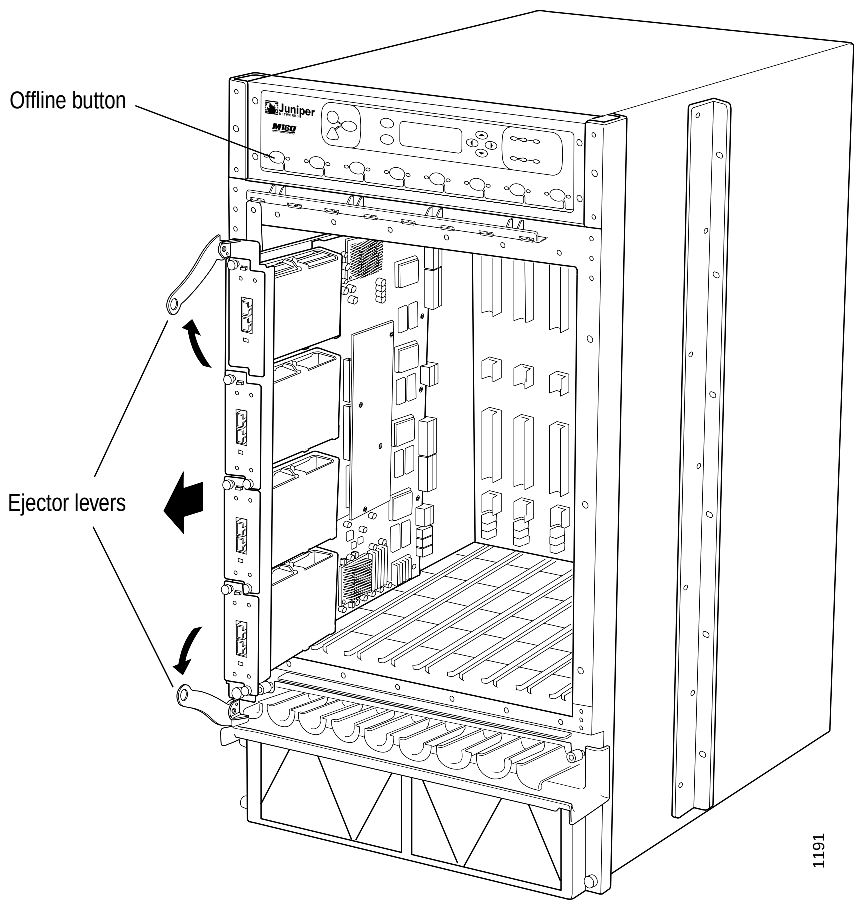
To remove an FPC, follow this procedure:

1. Have ready a replacement FPC or blank card carrier, and an antistatic mat for the FPC. Also have ready rubber safety caps for each PIC using an optical interface on the FPC that you are removing.

2. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

3. As you face the front of the chassis, locate the two LEDs and offline button directly above the FPC that you plan to remove (see Figure 84).

Figure 84: Remove an FPC



4. Take the FPC offline by pressing its offline button. Press and hold the button until the FPC OK LED turns off (about 5 seconds).

5. Label the cables connected to each PIC on the FPC so that you can later reconnect each cable to the correct PIC.

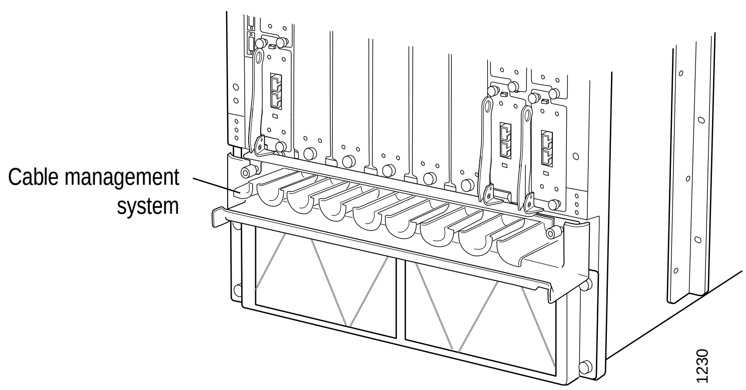
> **Caution**
>
> Do not look directly into the PIC cable connectors or into the ends of optical fiber cables. PICs that use SONET/SDH or ATM single-mode optical fiber contain laser light sources that can damage your eyes.

6. Remove the cable connectors plugged into each PIC on the FPC and immediately place a rubber safety cap over each cable connector.

7. Carefully drape each disconnected cable over the hooks in the cable management system directly below the FPC card cage (see Figure 85) to prevent the cables from developing stress points.

> **Caution**
>
> Avoid bending fiber-optic cable beyond its minimum bend radius. An arc smaller than a few inches in diameter can damage the cable and cause problems that are difficult to diagnose.

Figure 85: Cable Management System on the Chassis



8. Flip the ends of the ejector levers outward until they are nearly perpendicular to the FPC (see Figure 84).

9. Grasp the top and bottom flanges of the card carrier and slide the FPC about halfway out from the card cage.

> **Caution**
>
> Avoid grasping the ejector levers, bus bars, or edge connectors of the FPC while removing it. They cannot support the weight of the FPC.

10. Place one hand around the front of the FPC (the PIC housing) and the other hand on the bottom of the FPC.

> **Caution**
> The weight of the FPC is concentrated in the back end. Be prepared to accept the full weight as you pull the FPC out of the chassis.

11. Pull the FPC completely out from the chassis.

> **Caution**
> Do not stack the FPCs after you remove them.

12. Place the removed FPC on an antistatic mat.

13. If necessary, remove each PIC from the FPC by loosening the screws that attach the PIC to the FPC and then pulling the PIC out of its FPC connector.

14. After you remove each PIC, immediately place it on an antistatic mat.

Install an FPC

To install an FPC, follow this procedure (see Figure 86):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Place the replacement FPC on an antistatic mat.

3. Take each replacement PIC out of its electrostatic bag and identify the slot on the FPC where it will be connected.

4. Verify that each PIC has a rubber safety cap covering the PIC cable connector. If it does not, place a rubber safety cap over the cable connector.

5. Slide each PIC into its appropriate slot on the FPC, aligning the notches at the rear connector on the PIC with the notches in the FPC PIC slot and then firmly pushing the PIC into place.

6. Tighten the two thumbscrews that fasten each PIC to the FPC.

> **Note**
> To seat the FPCs properly, be sure to tighten the screws adequately.

7. Locate the slot in the FPC card cage in which you plan to install the FPC.

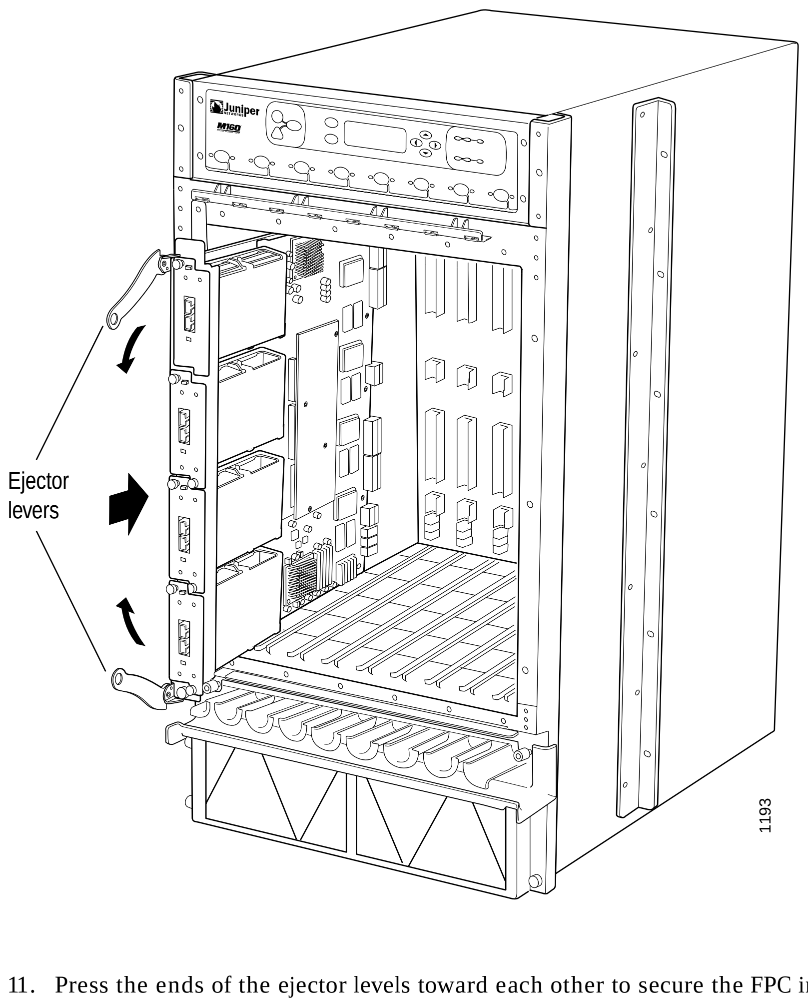
8. Move the ejector levers at the top and bottom of the FPC card carrier so that they are protruding perpendicular to the FPC.

9. Lift the card carrier and vertically align the rear of the card carrier with the guides at the top and bottom of the slot.

> **Caution**
>
> Avoid grasping the ejector levers, bus bars, or edge connectors of the FPC while removing it. They cannot support the weight of the FPC.

10. Slide the FPC all the way into the card cage until it contacts the midplane.

Figure 86: Install an FPC



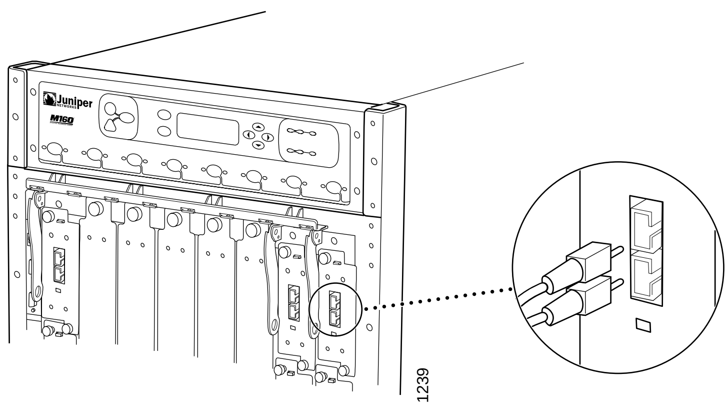
11. Press the ends of the ejector levels toward each other to secure the FPC in the slot.

12. Remove the rubber safety cap from the PIC cable connector.

> **Warning**
> Do not look directly into the PIC cable connectors or into the ends of optical fiber cable. PICs that use SONET/SDH or ATM single-mode optical fiber contain laser light sources that can damage your eyes.

13. Insert the appropriate cable connector into the PIC cable receptacle (see Figure 87).

Figure 87: Connect Fiber-Optic Cable to a PIC



14. Secure the cables so that they are not supporting their own weight. Place excess cable out of the way in a neatly coiled loop, using the cable management system.

> **Caution**
> Never let cable hang free from the connector. Do not allow fastened loops of cable to dangle from the ladder rack, because this stresses the cable at the fastening point.

15. Bring the FPC online by pressing its offline button. Press and hold the button until the FPC ONLINE LED lights (about 5 seconds.).

Verify That the FPC is Installed Correctly

When the FPC is seated and the offline button is pressed, if the router is operational, the Routing Engine downloads the FPC software, the FPC runs its diagnostics, and the PICs on the FPC card are enabled. You can verify that this process is occurring by checking that the green OK LED above the FPC is blinking as the FPC starts up. The midplane flushes the entire system memory pool before the new card is brought online, a process that takes about 200 ms. When the FPC is online, the green OK LED above the FPC is on steadily.

To check the status of the FPCs and PICs with the CLI, use the following command:

user@host> **show chassis fpc pic-status** *fpc-slot*

For more information about using the CLI to get information about the FPCs and PICs, see the JUNOS Internet software manuals.

You can check the status of the PICs by observing the status LED on the PIC faceplate below the optical transceiver. If the FPC that houses the PIC detects a PIC failure, the FPC informs the MCS, which in turn sends an alarm to the Routing Engine.

For information on the meanings of the PIC LED states, see the *M160 Internet Router PIC Guide*.

Replace a PIC

PICs are hot-insertable and hot-removable. When you remove a PIC, the router continues to function, although the PIC interfaces being removed no longer function. This section discusses the following topics:

- Remove a PIC on page 194
- Install a PIC on page 196
- Verify That the PIC is Installed Correctly on page 197

Remove a PIC

The PICs are located in the FPCs installed in the front of the router.

To remove a PIC, follow this procedure (see Figure 88):

1. Have ready a replacement PIC or PIC blank panel, an antistatic mat for the PIC, and a rubber safety cap for the PIC transceiver.

2. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

3. Take the PIC offline by pressing its offline button. Press and hold the button until the PIC LED lights red (about 5 seconds). PICs in an FPC1 have their offline buttons on the FPC, while PICs on an FPC2 have their offline buttons on the PIC faceplate.

4. Label the cables connected to the PIC so that you can later reconnect each cable to the correct PIC.

> **Caution**
>
> Do not look directly into the PIC cable connectors or into the ends of optical fiber cable. PICs that use SONET/SDH or ATM single-mode optical fiber contain laser light sources that can damage your eyes.

5. Remove the cable connectors plugged into each PIC and immediately place a rubber safety cap over each cable connector.

6. Carefully drape each disconnected cable over the hooks in the cable management system directly below the FPC card cage to prevent the cables from developing stress points.

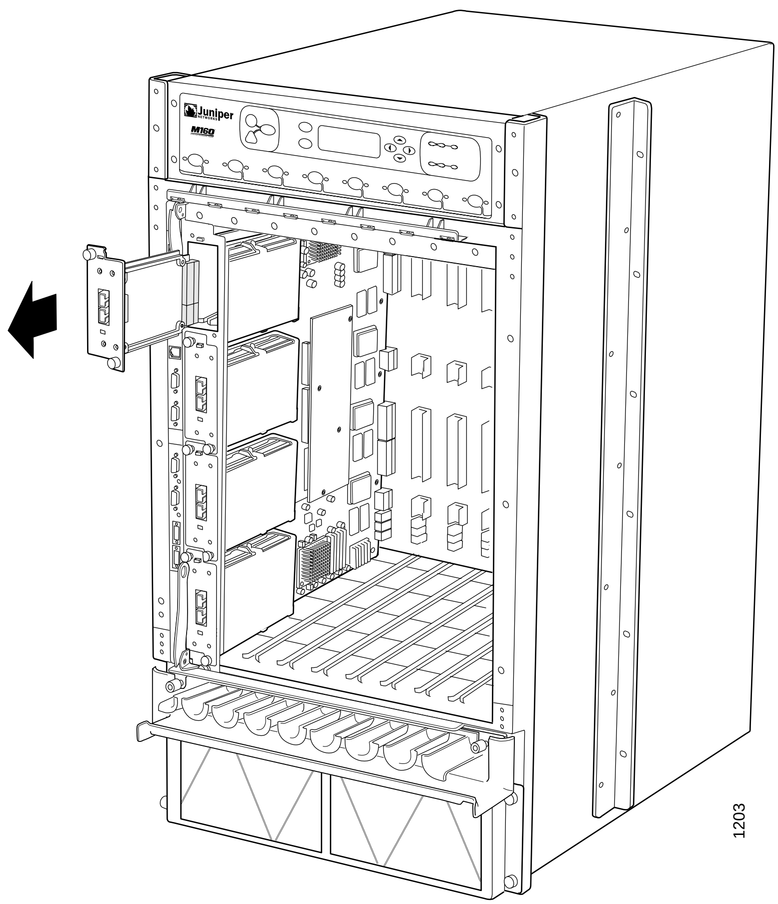
> **Caution**
>
> Avoid bending PIC cables beyond their bend radius. Arcs smaller than a few inches can damage the cables and cause problems that are difficult to diagnose.

7. Loosen the thumbscrews at the top and bottom of the PIC faceplate to unseat the PIC.

8. Slide the PIC out of the FPC card carrier.

9. Place the removed PIC on an antistatic mat.

Figure 88: Remove a PIC



Install a PIC

To install a PIC, follow this procedure (see Figure 89):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Take the replacement PIC out of its electrostatic bag and place it on an antistatic mat.
3. Each PIC with an optical interface should have a rubber safety cap covering the PIC cable connector. If it does not, place a rubber safety cap over the cable connector.
4. Slide each PIC into its appropriate slot on the host FPC, aligning the notches at the rear connector on the PIC with the notches in the host FPC PIC slot and then firmly pushing the PIC into place.

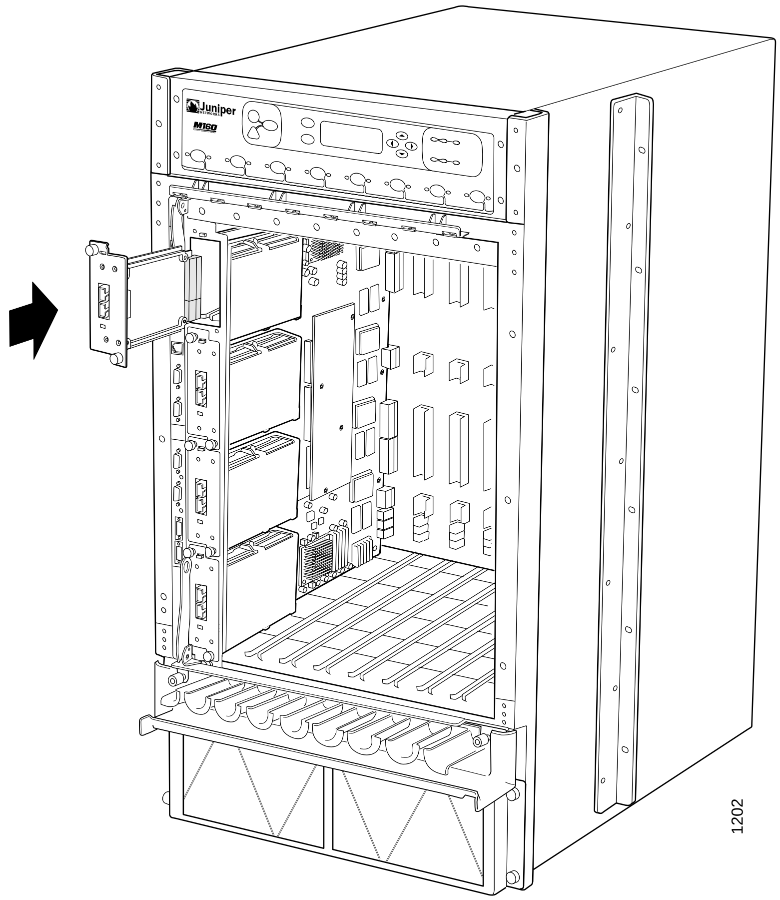
> **Caution**
>
> Be careful to insert the PIC straight into the FPC slot to avoid damaging the components on the bottom of the PIC.

5. To secure the PIC to the FPC, tighten the thumbscrews on the PIC faceplate.
6. Remove the rubber safety cap from the PIC cable connector.

> **Caution**
>
> Do not look directly into the PIC cable connectors or into the ends of optical fiber cable. PICs that use SONET/SDH or ATM single-mode optical fiber contain laser light sources that can damage your eyes.

7. Connect the appropriate cable connector to the PIC cable receptacle.
8. Carefully drape each PIC cable over the hooks in the cable management system directly below the FPC card cage to prevent the cables from developing stress points.
9. Bring the PIC online by pressing its offline button. Press and hold the button until the PIC LED lights green (about 5 seconds.). PICs in an FPC1 have their offline buttons on the FPC, while PICs on an FPC2 have their offline buttons on the PIC faceplate.

Figure 89: Install a PIC



Verify That the PIC is Installed Correctly

Each PIC has a status LED located beneath the optical transceiver on the PIC faceplate. When the PIC comes online, the LED should light steadily with a green light.

To check the status of the PICs using the CLI, use the following command:

user@host> **show chassis fpc pic-status** *fpc-slot*

For more information about using the CLI to get information about the FPCs and PICs, see the JUNOS Internet software manuals. For information on the meanings of the PIC LED states, see the *M160 Internet Router PIC Guide*.

Maintain the SFMs

To maintain the SFMs, follow these guidelines:

- Check the SFM LEDs to observe the status of the SFMs. For more information, see “Switching and Forwarding Modules (SFMs)” on page 13.
- To display information about the SFMs, use the following CLI command:

  user@host> **show chassis sfm**

  To display more detailed information, use the following command:

  user@host> **show chassis sfm detail**

  For more information about using the command-line interface, see the *JUNOS Internet software manuals*.

Replace an SFM

The SFMs are hot-pluggable. When you remove an SFM, a brief interruption (about 500 ms) occurs in the forwarding function of the router while the Packet Forwarding Engine reconfigures the distribution of packets.

To replace an SFM, use the following procedures:

- Remove an SFM on page 198
- Install an SFM on page 199
- Verify That the SFM is Installed Correctly on page 200

Remove an SFM

The router can have from one to four SFMS installed. The SFMs are located in the rear of the chassis, in the slots labeled SFM0 through SFM3. Each SFM weighs approximately 5 lbs (2.3 kg).

To remove an SFM, follow this procedure (see Figure 90):

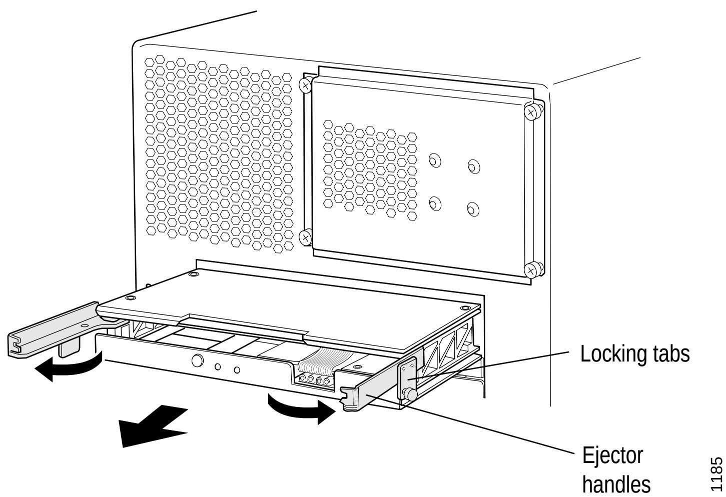
1. Have ready an antistatic mat for the SFM.
2. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
3. Remove the rear component cover by loosening the screws on the corners of the cover and pulling it straight out from the chassis.
4. Press the offline button on the SFM faceplate and hold it down until the SFM OK LED turns off (about 5 seconds).
5. Loosen the thumbscrews on the ejector locking tabs joining the two SFM boards.
6. Flip the ends of the ejector handles outward.

7. Grasp the handles, pull firmly on the SFM, and slide the unit about three-quarters of the way out of the chassis.

8. Move one of your hands underneath the SFM to support it, and slide it completely out of the chassis.

> **Caution**
>
> Do not stack the SFMs. The power connectors on each SFM can be damaged if the SFMs are stored in a way that puts pressure on the connectors.

Figure 90: Remove an SFM



Install an SFM

To install an SFM into the rear of the chassis, follow this procedure (see Figure 91):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Hold the SFM by placing one hand underneath to support it and the other hand on one of the ejector handles on the front of the unit.

3. Align the rear of the SFM with the guides inside the chassis.

4. Slide the unit completely into the chassis.

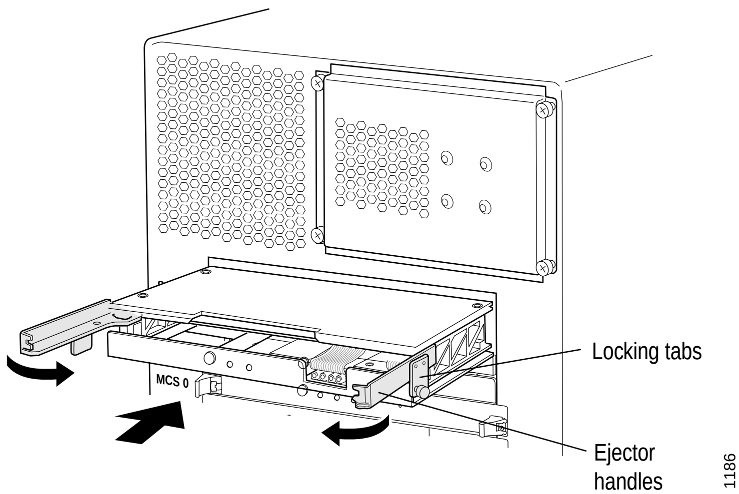
5. Press the ejector handles on the left and right sides of the SFM inward.

6. Tighten the thumbscrews on the ejector locking tabs.

7. Press the offline button on the SFM faceplate and hold it down until the green OK LED lights (about 5 seconds).

8. Reinstall the rear component cover and tighten the screws on the covers of the corner to secure it to the chassis.

Figure 91: Install an SFM



Verify That the SFM is Installed Correctly

To verify that the SFM is functioning normally, check the LEDs on its faceplate. The green OK LED should light steadily.

To check the status of the SFMs, use the following CLI command:

```
user@host> show chassis sfm
```

For more information about using the CLI, see the *JUNOS Internet software manuals*.

Maintain the PCGs

To maintain the PCGs, follow these guidelines:

- Check the PCG LEDs to observe the status of the PCGs. For more information, see the section “PFE Clock Generators (PCGs)” on page 18.

- To display information about the PCGs, use the following CLI command:

  ```
  user@host> show chassis environment pcg
  ```

  For more information about using the command-line interface, see the *JUNOS Internet software manuals*.

Replace a PCG

The PCGs are hot-pluggable. If both PCGs are installed and functioning normally, PCG0 is the master PCG and PCG1 is the backup. Removing the backup PCG does not affect the functioning of the router. Taking the master PCG offline causes the FPCs and SFMs to power down and restart with the other PCG selected as master. The forwarding and routing functions are interrupted during this process.

You can determine which PCG is functioning as master in one of two ways:

- Check the blue MASTER LED on the PCG faceplate. If this LED is on steadily, the PCG is functioning as master.
- To display which PCG is functioning as master, use the following CLI command:

  user@host> **show chassis environment pcg**

This section discusses the following topics related to replacing the PCGs:

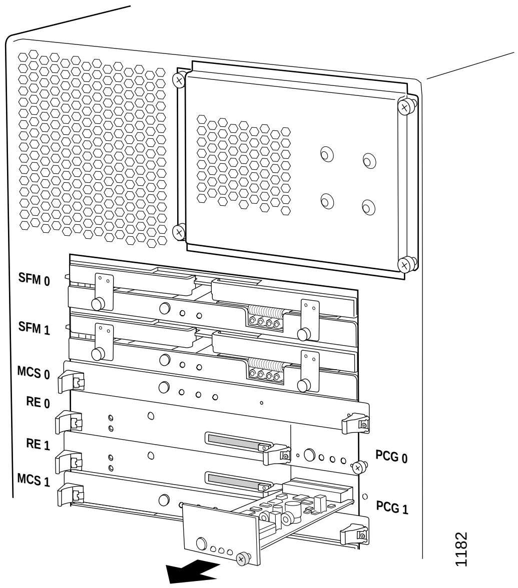
Remove a PCG

The router has two PCGs. They are located in the rear of the chassis, in the slots labeled PCG0 and PCG1, to the right of the Routing Engine slots. Each PCG weighs approximately 1 lb (0.5 kg).

To remove a PCG, follow this procedure (see Figure 92):

1. Have ready an antistatic mat.
2. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
3. Remove the rear component cover by loosening the screws on the corners of the cover and pulling it straight out from the chassis.
4. Press the offline button on the faceplate of the PCG and hold it down until the PCG OK LED turns off (about 3 seconds).
5. Loosen the thumbscrew on the right side of the PCG.
6. Slide out the PCG, grasping it by the screw.
7. Place the PCG on an antistatic mat.

Figure 92: Remove a PCG



Install a PCG

To install a PCG, use the following procedure (see Figure 93):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Remove the replacement PCG from its electrostatic bag.

3. Align the rear of the PCG with the guides inside the chassis.

4. Slide the PCG all the way into the card cage until it contacts the midplane.

5. Tighten the thumbscrew on the right side of the PCG faceplate.

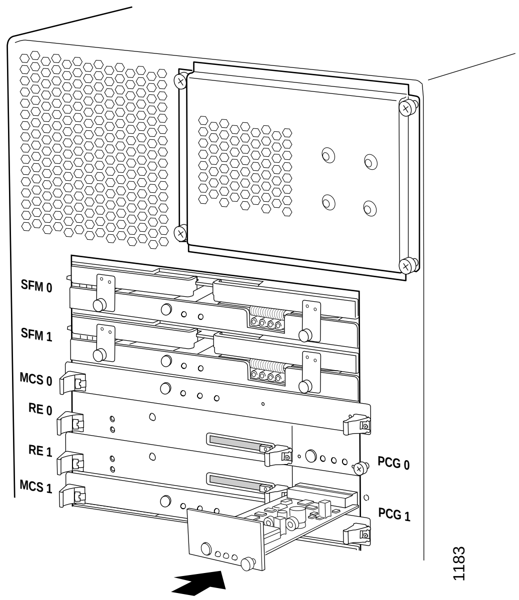
6. Verify that the PCG is properly installed by looking at the LEDs on the PCG faceplate. The green OK LED should light steadily.

7. Reinstall the rear component cover and tighten the thumbscrews on the corners of the cover to secure it to the chassis.


Note

Make sure that you tighten the screw on the PCG so that it is seated properly.

Figure 93: Install a PCG



Verify That the PCG is Properly Installed

To verify that the PCG is functioning normally, check the LEDs on its faceplate. The green OK LED should light steadily.

To check the status of the PCGs, use the following CLI command:

user@host> **show chassis environment pcg**

For more information about using the CLI to get information, see the *JUNOS Internet software manuals*.

Chapter 13

Maintain and Replace Host Module Components

This chapter discusses the following topics about maintaining and replacing the host module components:

Tools and Parts Required

To replace host module components, you need the following the tools and parts:

- Phillips (+) screwdrivers, numbers 1 and 2
- Flat-blade (–) screwdrivers, 3/16-in. and 1/4-in.
- Electrostatic bags, one for each Routing Engine and MCS removed
- Antistatic mat
- ESD grounding wrist strap
- Replacement components or blank panels, one for each component that you are removing

Maintain the Host Module

The host module comprises a Routing Engine and its adjacent MCS functioning together. To maintain the host module components, use these guidelines:

- Check the host module LEDs on the craft interface. If the red FAIL LED is on, look at the display on the craft interface to get more information about the cause of the problem. For more information about the LEDs and the display, see "Craft Interface" on page 23.
- Check the display on the craft interface to view information about the router's temperature and the status of the Routing Engine.
- To check the state of the Routing Engine, use the following CLI command:

  user@host> **show chassis routing-engine**

- To check the state of the MCS, use the following CLI command:

  user@host> **show chassis environment mcs**

For more information about using the CLI, see the *JUNOS Internet software manuals*.

Take the Host Module Offline

The host module is taken offline and brought online as a unit. Before you replace a Routing Engine or an MCS, you take the host module offline. The host module is hot-pluggable.

Normally, if two host modules are installed in the router, HOST0 functions as the master and HOST1 as the backup. You can remove the backup host module (or either of its components) without interrupting the functioning of the router. If you take the master host module offline, the router reboots and the backup host module becomes the master. If the router has only one host module, taking it offline causes the router to shut down.

To take the host module offline, use the following procedure:

1. Determine whether the host module is functioning as master or as backup, using one of the following two methods:
   - Check the host module LEDs on the craft interface. If the green MASTER LED is lit, the corresponding host module is functioning as master.
   - Display which host module is functioning as the master using the CLI command:

     user@host> **show chassis routing-engine**

2. If the host module is master, you can switch the host module to backup using the CLI command:

   user@host> **request chassis routing-engine master switch**

   When you switch the host module from master to backup, the functioning of the router is interrupted for up to several minutes as the system reboots and the new master host module downloads software to the SFMs.

Replace the Routing Engine

The Routing Engine is hot-pluggable. To replace the Routing Engine, use the following procedures:

- Remove a Routing Engine
- Install a Routing Engine
- Verify that the Routing Engine Is Installed Correctly

Remove a Routing Engine

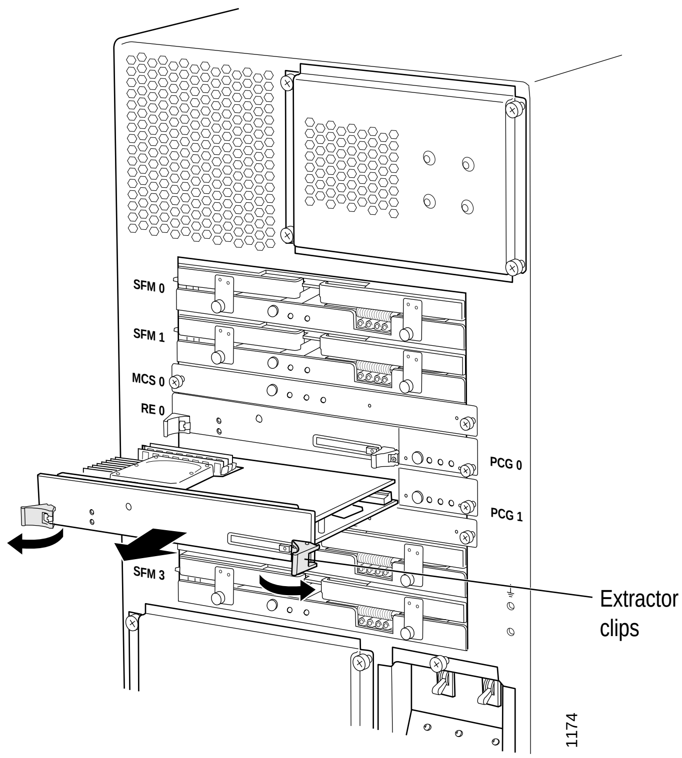
The router can have one or two Routing Engines. They are located in the rear of the chassis in the slots labeled RE0 and RE1. Each Routing Engine weighs approximately 1.5 lbs (0.7 kg).

To remove a Routing Engine, follow this procedure (see Figure 94).

1. Have ready an antistatic mat.
2. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
3. Remove the rear component cover by loosening the screws on the corners of the cover and pulling it straight out from the chassis.
4. Check whether the Routing Engine is functioning as backup or as master and, if necessary, take the host module offline. For more information, see "Take the Host Module Offline" on page 206.
5. Loosen the screws on the extractor clips on both sides of the Routing Engine faceplate.
6. Flip the extractor clips outward.
7. Grasp the extractor clips and slide the unit about halfway out of the chassis.
8. Move one of your hands underneath the Routing Engine to support it, and slide it completely out of the chassis.

> **Caution**
>
> Do not stack the Routing Engines. The top of the Routing Engine, especially the hard drive, can be damaged by contact.

Figure 94: Remove a Routing Engine



Install a Routing Engine

To install a Routing Engine, follow this procedure (see Figure 95):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.

2. Remove the replacement Routing Engine the from its shipping carton, leaving it inside its electrostatic bag.

3. Hold the Routing Engine by placing one hand underneath to support it and the other hand on one of the extractor clips on the faceplate.

4. Align the rear of the Routing Engine with the guides inside the chassis.

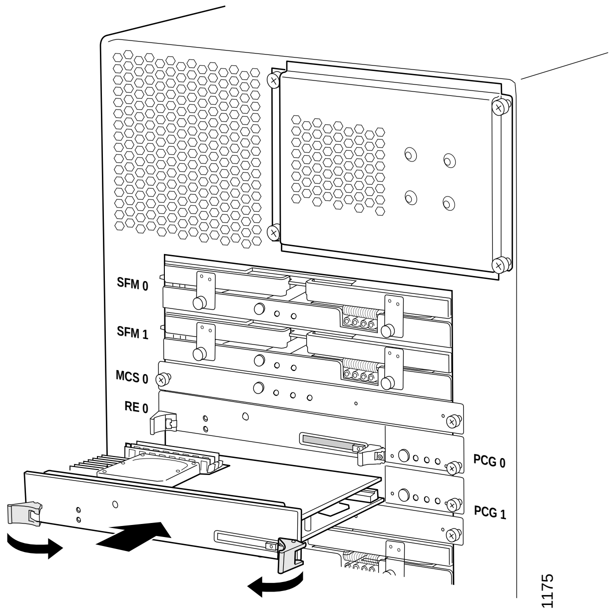
5. Slide the unit completely into the chassis.

6. Press the extractor clips on both sides of the Routing Engine faceplate inward.

7. Tighten the screws on the outside edges of the extractor clips.

8. Reinstall the rear component cover and tighten the screws on the corners of the cover to secure it to the chassis.

Figure 95: Install a Routing Engine



Verify that the Routing Engine Is Installed Correctly

To verify that the Routing Engine has been installed properly, check the HOST LEDs on the craft interface panel as soon as you have installed the Routing Engine. If the Routing Engine is functioning normally, the green ONLINE LED is on. If the red OFFLINE LED is on instead, the Routing Engine is not functioning normally. Contact your customer service representative if the Routing Engine is not functioning normally.

To check the status of the Routing Engine, use the CLI command:

user@host> **show chassis routing-engine**

For more information about using the CLI, see the *JUNOS Internet software manuals*.

Replace the MCS

The MCS is hot-pluggable. To replace the MCS, use the following procedures:

- Remove an MCS on page 210
- Install an MCS on page 211
- Verify that the MCS Is Correctly Installed on page 211

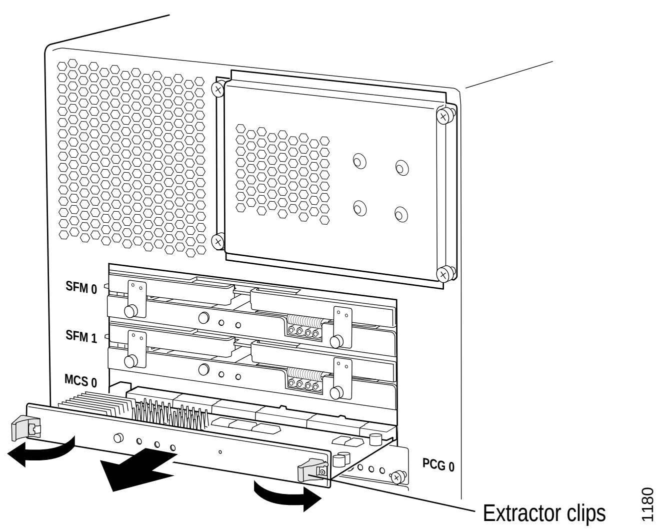
Remove an MCS

One or two MCSs can be installed in the router. They are located in the slots marked MCS0 and MCS1 in the rear of the chassis. Each MCS weighs approximately 2.5 lbs (1 kg).

To remove an MCS, follow this procedure (see Figure 96):

1. Have ready an antistatic mat.
2. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
3. Remove the rear component cover by loosening the screws on the corners of the cover and pulling it straight out from the chassis.
4. Check whether the MCS is functioning as backup or as master and, if necessary, take the host module offline. For more information, see “Take the Host Module Offline” on page 206.
5. Flip the extractor clips outward.
6. Slide out the MCS, grasping it by the extractor clips.
7. Place the MCS on an antistatic mat.

Figure 96: Remove an MCS

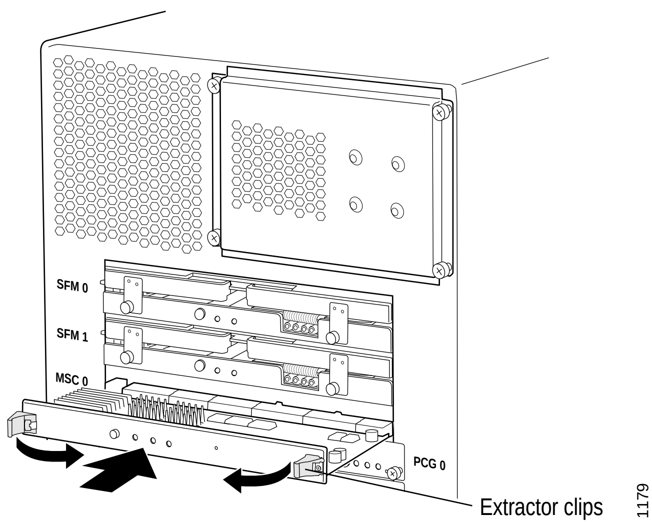


Install an MCS

To install an MCS, follow this procedure (see Figure 97):

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Remove the replacement MCS from its electrostatic bag.
3. Align the rear of the MCS with the guides in the MCS slot on the chassis.
4. Slide the MCS all the way into the card cage until it contacts the midplane.
5. Press the extractor clips on both sides of the MCS faceplate inward.
6. Reinstall the rear component cover and tighten the screws on the corners of the cover to secure it to the chassis.

Figure 97: Install an MCS



Verify that the MCS Is Correctly Installed

To verify that the MCS is functioning normally, check the LEDs on its faceplate. The green OK LED should light steadily.

To check the status of the MCS, use the CLI command:

user@host> **show chassis environment mcs**

For more information about using the CLI, see the *JUNOS Internet software manuals*.

Replace the PC Card

The router uses a PC card to store software images and upgrades. You can use only one type of PC card, a Sandisk 110-MB PCMCIA card. The PC card is hot-insertable and hot-removable.

Remove the PC Card

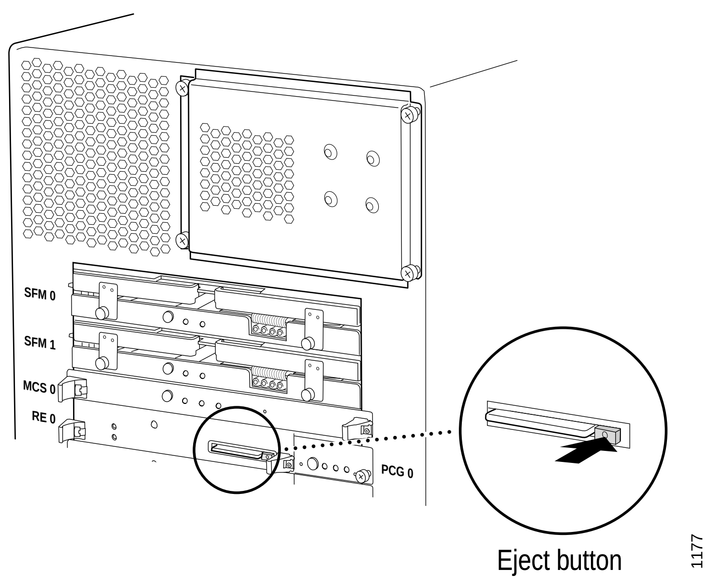
The PC card is inserted in the slot labeled PCMCIA on the Routing Engine faceplate. To remove the PC card, follow this procedure (see Figure 98).

1. Remove the rear component cover by loosening the screws on the corners of the cover and pulling it straight out from the chassis.

2. On the Routing Engine faceplate, press the eject button on the right side of the PC card slot.

3. The PC card pops partially out of the slot. Grasp the card and pull it straight out the rest of the way.

Figure 98: Remove the PC Card

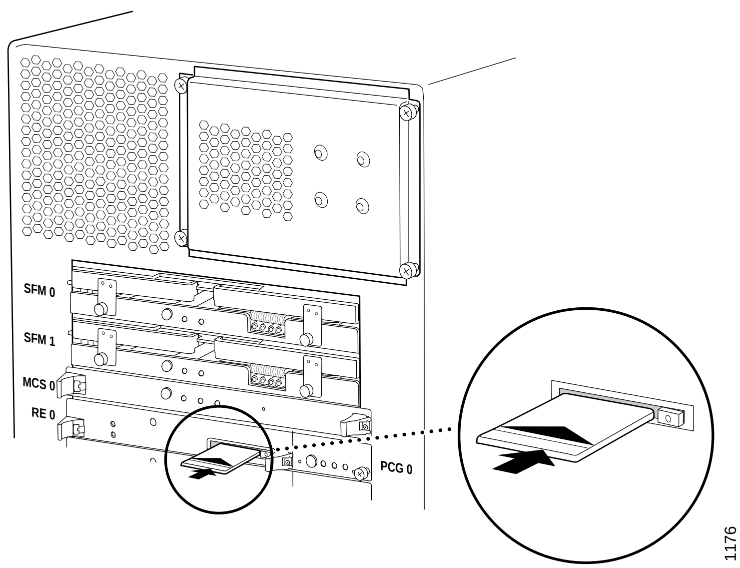


Install the PC Card

To install the PC card, follow this procedure:

1. Insert the PC card into the PC card slot, following the directions on the card and on the Routing Engine faceplate.
2. Press the card firmly all the way into the slot (see Figure 99).
3. Reinstall the rear component cover and tighten the screws on the corners of the cover to secure it to the chassis.

Figure 99: Install the PC Card



Chapter 14
Maintain and Replace the Connector Interface Panel

This chapter discusses the following topics related to maintaining and replacing the Connector Interface Panel (CIP):

- Tools and Parts Required on page 215
- Maintain the CIP on page 215
- Replace the CIP on page 215
- Verify that the CIP is Installed Correctly on page 218

Tools and Parts Required

To replace the CIP, you need the following tools and parts:

- Phillips (+) screwdriver, number and 2
- ESD grounding wrist strap

Maintain the CIP

The CIP requires no special maintenance.

Replace the CIP

The CIP is field-replaceable, but is not hot-removable, hot-insertable, or hot-pluggable. You must power down the router before removing or installing it.

Exercise caution when installing and removing the CIP to avoid damaging the connecting pins on the front of the midplane.

Remove the CIP

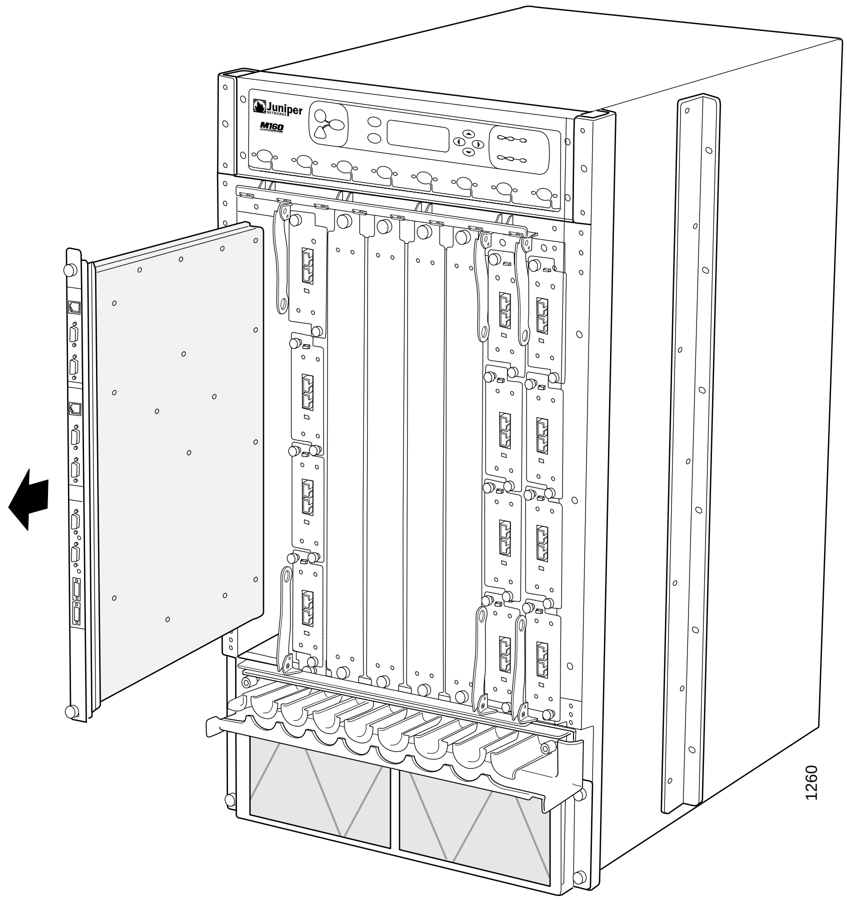
The CIP is located on the left side of the FPC card cage, occupying the length of the card cage. The CIP weighs about 6.5 lbs (3 kg).

To remove the CIP, follow this procedure:

1. Attach an ESD wrist strap to your bare wrist, and connect the wrist strap to one of the two ESD points on the chassis.
2. Power down the router.
3. Turn both the circuit breakers on the circuit breaker box to the OFF position.
4. Disconnect any external devices connected to the CIP.
5. Loosen the screws on the top and bottom of the CIP faceplate.
6. Carefully pull the CIP straight out of the chassis.

> **Caution**
>
> Exercise caution when installing and removing the CIP to avoid damaging the connecting pins on the front of the midplane.

Figure 100: Remove the CIP



Install the CIP

To install the CIP, follow this procedure (see Figure 101):

1. Carefully insert the CIP into the left side of the FPC card cage, following the guides on the top and bottom of the FPC card cage.

> **Note:** The components on the CIP are on the left side of the board, unlike the components of an FPC, which are on the right side. Be sure to install the CIP correctly, with the components on the left side.

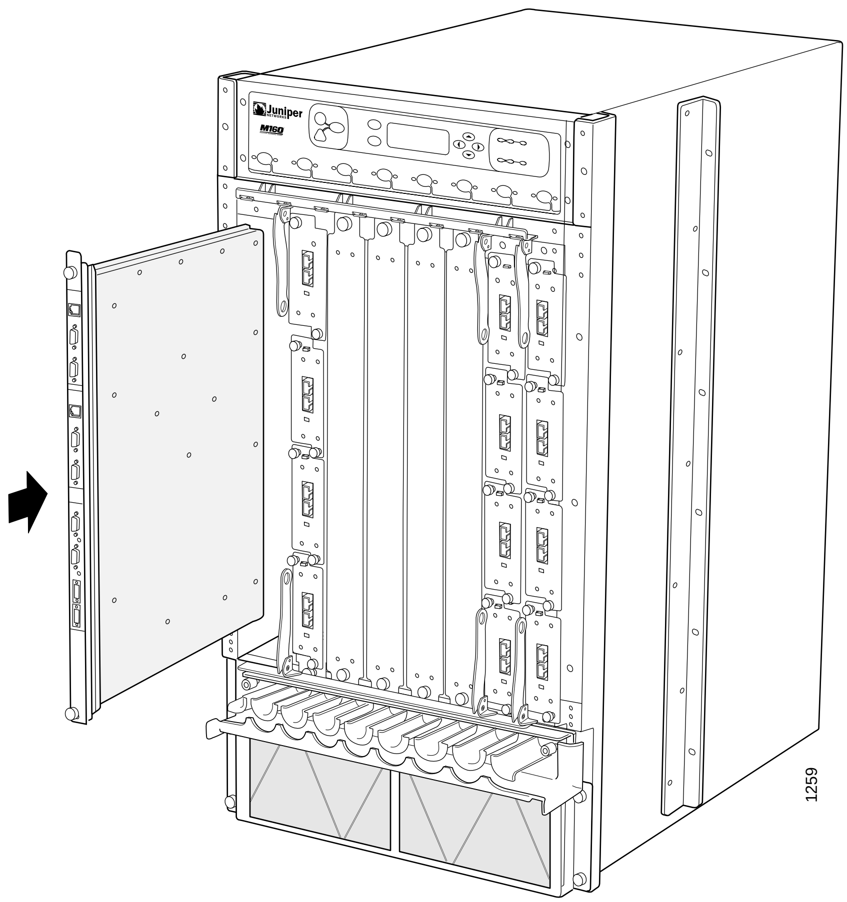
2. Push the CIP straight into the chassis until it contacts the midplane.

3. Tighten the screws on the top and bottom of the CIP faceplate.

4. Reattach any external devices connected to the CIP.

Caution	Exercise caution when installing and removing the CIP to avoid damaging the connecting pins on the front of the midplane.

Figure 101: Install the CIP



Verify that the CIP is Installed Correctly

To verify that the CIP is installed correctly, plug an Ethernet cable into the Ethernet port on the CIP. If the host module is operational, the LINK LED (either the yellow 10 Mbps or the green 100 Mbps LED) will flash to register Ethernet activity. If you can run the CLI, the CIP is installed correctly.

Chapter 15
Maintain and Replace Cables and Connectors

This chapter discusses the following topics related to maintaining and replacing the router's cables and connectors:

Cable Specifications

Table 31 list specifications for PIC and Routing Engine cable used in the router.

Table 31: Network Cable Specifications

Cable Type	Cable Specification	Supplied	Maximum Length	Connector Specification
Single-mode interface (fiber)	SC-SC duplex	No	Short reach: 1.25 mi (2 km)	SC
			Intermediate reach: 9.3 mi. (15 km)	SC
Multimode interface (fiber)	SC-SC duplex	No	1.25 mi. (2 km)	SC
Routing Engine console interface	RS-232 serial	One 6-ft. length with DB-9/DB-9 connectors	6 ft. (1.83 m)	DB-9 female
Routing Engine auxiliary interface	RS-232 serial	No	6 ft. (1.83 m)	DB-9 female
Routing Engine Ethernet interface	Category 5 cable or equivalent suitable for 100BaseT operation	One 15-ft. length with RJ-45/RJ-45 connectors	328 ft. (100 m)	RJ-45

Maintain the PIC Cables

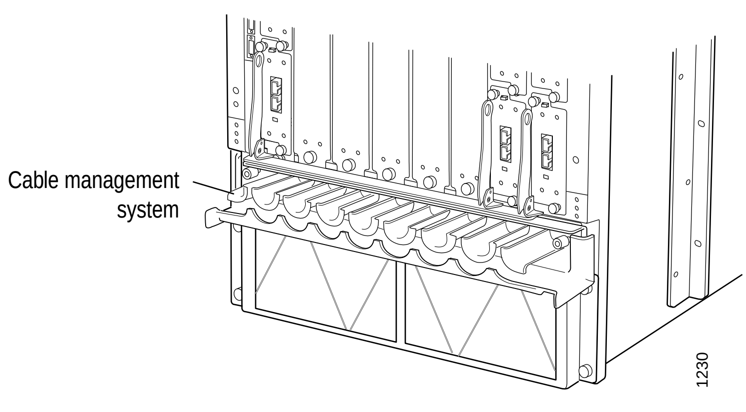
To maintain PIC cable properly, follow these guidelines:

- Use the cable management system below the FPC card cage (see Figure 102) to support cables and prevent cables from dislodging or developing stress points.
- Place excess cable out of the way in the cable management system—placing fasteners on the loop help to maintain its shape. Do not allow fastened loops of cable to dangle from the ladder rack because this stresses the cable at the fastening point.
- Keep the cable connections clean and free of dust and other particles, which can cause drops in the received power level. Always inspect cables and clean them if necessary before connecting an interface.
- Label all PIC cables to identify them, labeling each end of the cable the same.

The following guidelines apply specifically to fiber-optic cable:

- When you unplug a fiber-optic cable from a PIC, always place a rubber safety plug over the connector.
- Keep fiber-optic cable connections clean using an appropriate fiber-cleaning device, such as RIFOCS 945/946 Fiber Optic Connector Cleaning System.
- Anchor fiber-optic cable to avoid stress on the connectors—when attaching fiber to a PIC, be sure to secure the fiber so it is not supporting its own weight as it dangles to the floor. Never let fiber-optic cable hang free from the connector.
- Avoid bending fiber-optic cable beyond its bend radius—an arc smaller than a few inches can damage the cable and cause problems that are difficult to diagnose.
- Frequent plugging and unplugging of fibers into or out of optical instruments, such as SONET/SDH or ATM analyzers, might damage the instruments, which are expensive to repair. We recommend attaching a short fiber extension to the optical equipment. Any wear and tear due to frequent plugging and unplugging is then absorbed by the short fiber extension, which is easy and inexpensive to replace.

Figure 102: Cable Management System on the Chassis



Replace PIC Cables

To replace the PIC cables, follow this procedure (see Figure 104). You can complete this procedure without powering down the router.

> **Warning**
>
> If you do not have a replacement rubber plug in your hand, do not unplug the fiber from a PIC. The safety plug keeps the connection clean and prevents accidental exposure to light that might be emitted, which could damage your eyes.

> **Warning**
>
> Do not look directly into the PICs installed in the FPC or into the ends of optical fiber cable. PICs that use SONET/SDH or ATM single-mode optical fiber contain laser light sources that can damage your eyes.

1. Identify the appropriate cable to be connected to each PIC (see Table 31).

2. Remove the rubber safety plug from the PIC cable receptacle.

3. Insert the appropriate cable connector into the PIC cable receptacle (see Figure 103).

4. Drape cable over the struts of the cable management system at the lower front of the chassis to prevent cables from dislodging or developing stress points. Secure the fiber so that it is not supporting its own weight as it dangles to the floor. Place excess fiber out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.

> **Caution**
>
> Never let fiber-optic cable hang free from the connector. Do not allow fastened loops of cable to dangle, because this stresses the cable at the fastening point.

Figure 103: PIC Fiber-Optic Cable Connector

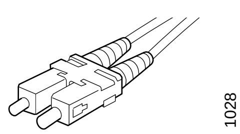
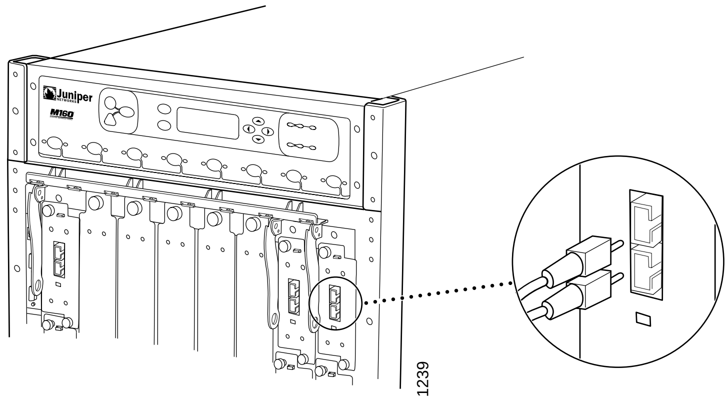


Figure 104: Connect Fiber-Optic Cable to a PIC



Verify that the PIC Cables Are Installed Properly

Each port on each PIC has one LED, located on the PIC faceplate below the optical transceiver. PIC LEDs have four different states, which are described in Table 32. If the cable is installed properly, the PIC LED is green. If the FPC that houses the PIC detects a PIC failure, the FPC informs the MCS, which in turn sends an alarm to the Routing Engine

Table 32: PIC LED States

Color	State	Description
Red	Fail	The host FPC has detected a PIC failure.
Green	Normal	The port is functioning normally.
Amber	Problem detected; still functioning	To track the problem, use the command-line interface.
None	Not enabled	The port is not enabled, or the PIC is offline.

You can check the status of each port on each PIC by observing its LED. You can also check PIC LED status by using the CLI command:

user@host> **show chassis fpc pic-status** *fpc-slot*

For more information about the CLI commands, see the *JUNOS Internet software manuals*.

Replace the Power Cables

To replace the DC power cables, you must disconnect power to the router, then reconnect power using the replacement cables:

- Disconnect Power to the Router on page 223
- Connect Power to the Router on page 223

Disconnect Power to the Router

To disconnect the DC power cable from the circuit breaker box, follow this procedure:

1. Ensure the voltage across the DC power source cable leads connected to the circuit breaker box is 0 V and that there is no chance that the cables might become active during the disconnection process.

Caution	There is no color code standard for the DC wiring. The color coding used by the site DC power source determines the color coding of the DC power cable leads to the circuit breaker box. You must ensure that the proper polarity is connected to the circuit breaker box. The power source DC cables might be marked with a (+) or a (–) label, indicating the cable polarity.

2. Loosen the nuts securing the cable lugs to the terminal studs on the circuit breaker box (see Figure 105 on page 225).

3. Remove the nut and washer from each terminal stud.

4. Remove the cable lugs from the terminal studs.

5. Unscrew the nut fastening the grounding lug to the chassis.

   Be sure that the cables are not touching or in the way of any system components.

Connect Power to the Router

Power and grounding cables must be the proper type and use appropriate cable lugs. For specifications on the power and grounding cables, see “Power and Grounding Cable Specifications” on page 61.

To connect the DC power cabling to the circuit breaker box, follow this procedure (see Figure 105):

1. Ensure the voltage across the DC power source cable leads that you will connect to the circuit breaker box is 0 V and that there is no chance that the cable leads might become active during installation.

Caution	There is no color code standard for the DC wiring. The color coding used by the site DC power source determines the color coding of the DC power cable leads to the circuit breaker box. You must ensure that the proper polarity is connected to the circuit breaker box. The power source DC cables might be marked with a (+) or a (–) label, indicating the cable polarity.

2. Place the grounding cable lug over the grounding points on the right rear of the chassis. The grounding cable should already be attached to a proper earth ground for both DC power sources.

3. Secure the grounding cable lug to the grounding points, first with the washer, then with the bolt.

4. Remove the clear cover from the circuit breaker box.

5. Attach the power cable lugs for both power sources to the terminal studs on the circuit breaker box (see Figure 105).

6. Remove the nut and washer from each terminal stud and attach the source DC power cable lugs to the power terminals:

   - Connect the positive (+) source DC power cable lug to the RTN (return) terminal on the circuit breaker box.

   - Connect the negative (–) source DC power cable lug to the –48V (input) terminal on the circuit breaker box.

   Caution: The router must be connected to two DC power sources, one for each circuit breaker.

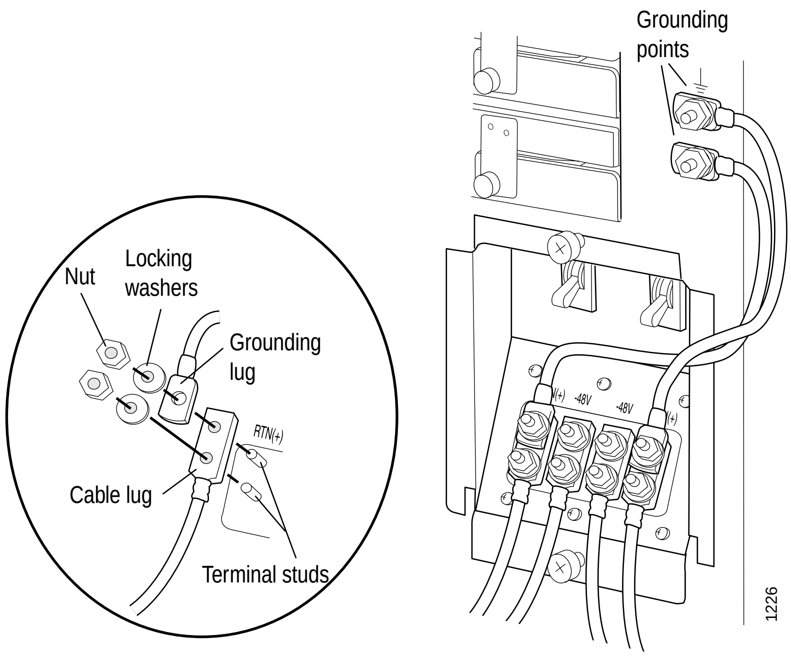
   Be sure that the cables are not touching or in the way of any system components.

7. Secure the power cable lugs to the terminal studs, first with the washer, then with the nut.

8. Verify that the DC source power cabling and the grounding cabling are correct.

9. Replace the clear cover.

Figure 105: Connect Power to the Circuit Breaker Box

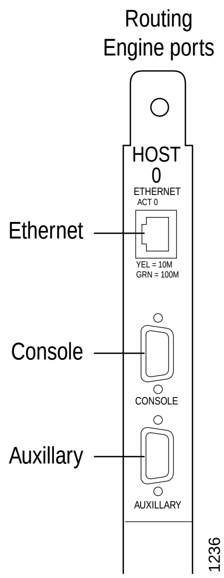


Replace Routing Engine External Cables

You can replace the following cables that connect external devices to the CIP (see Figure 106):

- Replace the Management Console Cable on page 226
- Replace Auxiliary Device Cable on page 227
- Replace Network Ethernet Cable on page 227
- Replace Alarm Relay Cables on page 227

Figure 106: External Management Ports on the CIP



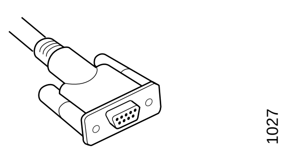
Replace the Management Console Cable

The Routing Engine management console cable connects to the CONSOLE serial port (see Figure 106). Refer to Table 31 on page 219 for cable specifications.

To connect a management console to the router, follow this procedure:

1. Locate the appropriate cable and connector (see Figure 107 and Table 31).
2. Turn off the console power switch.
3. Plug the female end of the console cable connector into the CONSOLE port on the CIP.
4. Tighten the screws on the connector.

Figure 107: Console and Auxiliary Serial Port Connector



Replace Auxiliary Device Cable

To connect a modem, laptop, or other auxiliary device to the router through the AUXILIARY serial port (see Figure 106), follow this procedure:

1. Locate the appropriate cable and connector (see Figure 107 and Table 31 on page 219).

2. Turn off the auxiliary device power switch.

3. Plug the female end of the auxiliary device cable connector into the AUXILIARY port on the CIP.

4. Tighten the screws on the connector.

Replace Network Ethernet Cable

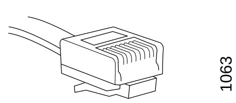
To connect the router to a network for out-of-band management through the ETHERNET (see Figure 106), follow this procedure:

1. Locate the appropriate cable and connector (see Figure 108, and Table 31 on page 219).

2. Plug one of the Ethernet cable connectors into the ETHERNET port on the CIP.

3. Plug the other end into the network device.

Figure 108: Routing Engine Ethernet Cable Connector



Replace Alarm Relay Cables

You can connect the router to an external alarm device so that conditions initiating a red or yellow alarm also trigger an external alarm device. Two sets of alarm relay contacts are located on the CIP. The upper alarm relay contact is triggered by a red alarm condition and the lower alarm card connector is triggered by a yellow alarm condition.

To connect alarm relay contact cables, follow this procedure:

1. Locate an appropriate length of 14–28 AWG wire for use with the alarm relay terminal blocks.

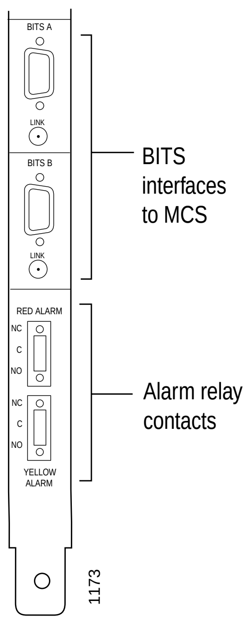
2. For the upper alarm cable, unscrew the small screws on the terminal block and attach the wire to the upper alarm relay contact (see Figure 109). This is the contact triggered by a red alarm condition.

3. Attach the other end of the wire to the external device to be activated by a higher-priority alarm.

4. For the lower alarm cable, unscrew the small screws on the terminal block and attach the second wire to the lower alarm relay contact (see Figure 109). The lower alarm relay is triggered by a yellow alarm condition.

5. Attach the other end of the second wire to the external device to be activated by a lower-priority alarm.

Figure 109: BITS Interfaces and Alarm Relay Contacts on CIP



Part 4 Troubleshooting

Chapter 16

Troubleshooting Overview

This chapter provides an overview of the following tools that you can use to troubleshoot the router:

- Command-Line Interface on page 231
- LEDs on page 232
- Display System Alarm Messages on page 233
- Contact Juniper Networks on page 235

The remaining chapters in this section describe general procedures for tracking the source of problems in router components including the cooling system, power supplies, and the Packet Forwarding Engine. If you encounter problems with other router components, including the Routing Engine, contact the Juniper Technical Assistance Center (JTAC) as described in "Contact Juniper Networks" on page 235.

Command-Line Interface

The primary means of controlling and troubleshooting the JUNOS Internet software, routing protocols, network connectivity, and the router hardware is to enter commands from the command-line interface (CLI). The CLI provides commands that let you display information in the routing tables, display routing protocol-specific information, and check network connectivity using the ping and traceroute commands.

The Routing Engine provides three ports on the Connector Interface Panel for connecting external management devices to the Routing Engine, providing access to the CLI:

- Console port—Connects a system console with RS-232 cable.
- Auxiliary port—Connects a laptop or modem with RS-232 cable.
- Ethernet management port—Connects the Routing Engine to a management LAN (or any other device that plugs into an Ethernet connection) for out-of-band management of the router system. The Ethernet port is 10/100–Mbps autosensing and requires an RJ-45 connector.

To display alarm messages using the CLI, see "Display System Alarm Messages."

For more information about using the CLI, see the *JUNOS Internet software manuals*.

LEDs

The router has LEDs which indicate the status of various components. This section describes the following types of LEDs:

- Craft Interface LEDs on page 232
- System LEDs on page 233

Craft Interface LEDs

The craft interface is the collection of mechanisms on the router that allow you to view system status messages and troubleshoot the router. The front panel of the craft interface is located on the lower impeller tray at the front of the chassis, and contains system LEDs, buttons, and an LCD display that provides status reporting for the entire system.

To display system alarm messages on the display, see "Display System Alarm Messages" on page 233. For more information about using the craft interface, see "Craft Interface" on page 23.

System LEDs on the craft interface include the following:

- FPC LEDs—Two LEDs (one green OK and one red FAIL) indicate the status of each FPC. The two LEDs and a function button are located above each FPC slot on the craft interface. For more information about these LEDs, see "FPC LEDs and Offline Button" on page 26.

- Host Module LEDs—Three LEDs (one blue MASTER, one green ONLINE and one red OFFLINE) indicate the status of each Host Module. The Host Module LEDs are located on the upper right of the craft interface. For more information, see "Host Module LEDs" on page 26.

- Alarm LEDs—One large red Alarm LED and one large amber Alarm LED indicate two levels of alarm conditions. You can determine the cause of the alarm condition by looking at the LCD display on the craft interface. For more information about these LEDs, see "Alarm LEDs and Alarm Cutoff Button" on page 23.

System LEDs

The following LEDs, which report the status of various system components, are located on the components rather than the craft interface:

- SFM LEDs—Two LEDs on the faceplate of each SFM indicate the status of that SFM. For more information about these LEDs, see “Switching and Forwarding Modules (SFMs)” on page 13.
- MCS LEDs—Three LEDs on the faceplate of the MCS indicate the status of the MCS. For more information about these LEDs, see “Miscellaneous Control Subsystem (MCS)” on page 21.
- PCG LEDs—Three LEDs on the faceplate of each PCG indicate the status of that PCG. For more information about these LEDs, see “PFE Clock Generators (PCGs)” on page 18.
- Power supply LEDs— Four LEDs, located on the faceplate of each power supply, indicate the status of the power supply. For more information about these LEDs, see “Power Supplies” on page 29.
- PIC LEDs—Each port on each PIC has one LED, whose color indicates the status of the port. For more information about these LEDs, see “Physical Interface Cards (PICs)” on page 17.

Display System Alarm Messages

The Routing Engine generates two classes of alarm messages:

- Chassis alarms—Caused by problems originating in chassis components such as the cooling system or power supplies. For example, a fan that stops spinning generates a chassis alarm. Table 33 lists the chassis alarm messages.
- Interface alarms—Caused by problems on specific network interfaces present in the router. For example, a fiber-optic connection that is lost generates an interface alarm. Table 34 lists the interface alarm messages.

You can view the short version of both classes of system alarm messages on the craft interface display. Using the CLI, you can view the longer version with the command:

user@host> **show chassis alarm**

Table 33: Chassis Alarm Messages

Component	LCD Short Version	CLI Long Version
Fans and impellers	Fan Failure	RED ALARM - *fan name* Failure
	Fan Removed	YELLOW ALARM - *fan name* Removed
	Fans Missing	RED ALARM - Too many fans missing or failing.
Temperature sensors	Temperature Warm	YELLOW ALARM - Temperature Warm (a temperature sensor in the chassis is reading above 65 degrees C)
	Temperature Hot	RED ALARM - Temperature Hot (a temperature sensor in the chassis is reading above 75 degrees C)
	Sensor Failure	RED ALARM - Temperature sensor failure
Power supplies	PEM *pem-number* Removed	YELLOW ALARM - PEM *pem-number* Removed
	PEM *pem-number* High Temp	RED ALARM - PEM *pem-number* High Temperature
	PEM *pem-number* Output Fail	RED ALARM - PEM *pem-number* Output Failure
	PEM *pem-number* Input Fail	RED ALARM - PEM *pem-number* Input Failure
SFMs	SFM *sfm-number* Failure	RED ALARM - SFM *sfm-number* Failure
	SFM *sfm-number* Removed	RED ALARM - SFM *sfm-number* Removed
Host modules	Host *host-number* Failure	RED ALARM - Host *host-number* Failure
	Host *host-number* Removed	Red ALARM - Host *host-number* Removed
Craft interface	Craft Failure	YELLOW ALARM - Craft Failure

Table 34: SONET/SDH Interface Alarm Messages

LCD Short Version	CLI Long Version
interface-name so-1/2/3 LOL	*interface-name* so-1/2/3 - SONET loss of light
interface-name so-1/2/3 PLL	*interface-name* so-1/2/3 - SONET PLL lock
interface-name so-1/2/3 LOF	*interface-name* so-1/2/3 - SONET loss of frame
interface-name so-1/2/3 LOS	*interface-name* so-1/2/3 - SONET loss of signal
interface-name so-1/2/3 SEF	*interface-name* so-1/2/3 - SONET severely errored frame
interface-name so-1/2/3 LAIS	*interface-name* so-1/2/3 - SONET line AIS
interface-name so-1/2/3 PAIS	*interface-name* so-1/2/3 - SONET path AIS
interface-name so-1/2/3 LOP	*interface-name* so-1/2/3 - SONET loss of pointer
interface-name so-1/2/3 BER	*interface-name* so-1/2/3 - SONET bit error rate defect
interface-name so-1/2/3 BER	*interface-name* so-1/2/3 - SONET bit error rate fault
interface-name so-1/2/3 LRDI	*interface-name* so-1/2/3 - SONET line remote defect indicator
interface-name so-1/2/3 PRDI	*interface-name* so-1/2/3 - SONET path remote defect indicator
interface-name so-1/2/3 REI	*interface-name* so-1/2/3 - SONET remote error indicator
interface-name so-1/2/3 UNEQ	*interface-name* so-1/2/3 - SONET unequipped
interface-name so-1/2/3 PMIS	*interface-name* so-1/2/3 - SONET path mismatch

Contact Juniper Networks

If while troubleshooting a problem you cannot determine the cause of a problem or need additional assistance, contact the Juniper Technical Assistance Center (JTAC) at support@juniper.net or at 1-888-314-JTAC (within the United States) or 408-745-2121 (from outside the United States).

Chapter 17
Troubleshoot the Power System

To verify that a power supply is functioning normally, do the following:

> **Note**
> On the display and in the CLI, the power supply mounted on the right side of the chassis is referred to as PEM A, and the power supply mounted on the left side is referred to as PEM B.

- Check the four LEDs on each power supply faceplate—if the green CB ON and the blue OUTPUT OK LEDs are on, the power source is good and the power supplies are functional. The CB ON LED on the power supply lights when the circuit breaker is functioning, and the OUTPUT OK LED lights when the power supply is receiving source DC power. The amber CB OFF LED lights when the power supply detects a fault (the power supply fails, does not have sufficient airflow, is going through a startup test, or is not properly inserted). The amber NO AIRFLOW LED lights when the power supply is not receiving enough airflow to maintain proper temperature.

- Check the display on the craft interface—the JUNOS software constantly updates the screen with status information for each component. For more information about the display, see "Craft Interface" on page 23.

- If the OUTPUT OK power supply LED is off, check the red alarm LED on the craft interface—the JUNOS software monitors the system temperature, and if it exceeds a certain limit, the software triggers a red alarm, a condition that shuts down the power supplies.

- If a red alarm condition occurs, check the display on the craft interface to determine the source of the problem.

> **Note**
> If the system temperature exceeds the threshold, the JUNOS software shuts down both power supplies so that no status is displayed. The JUNOS software also can shut down one of the power supplies for other reasons. In these cases, the redundant power supply assumes the load, and you can still view the system status through the CLI or display.

- If the OK power supply LED is off and no red alarm condition exists, check that the power switch is ON.

- Verify that the source DC circuit breaker has the proper current rating—each power supply in the router must be connected to a separate power source.

- Verify that the power cable or power cord from the power source to the router is not damaged—if the insulation is cracked or broken, immediately replace the cord or cable.

- Connect the power supply to a different power source with a new power cable—if the power supply OK LED still does not light, the power supply is the source of the problem. Replace the existing power supply with a spare, as described in "Maintain and Replace Power System Components" on page 161.

- If the OUTPUT OK LED on the installed spare lights, you can be sure that the replaced power supply is faulty, and you should return it for replacement, as described in "Return the Router or Its Components" on page 249.

- If the NO AIRFLOW LED on one of the power supplies lights, check the fans, impellers and air filter to be sure they are functioning and providing sufficient airflow through the chassis.

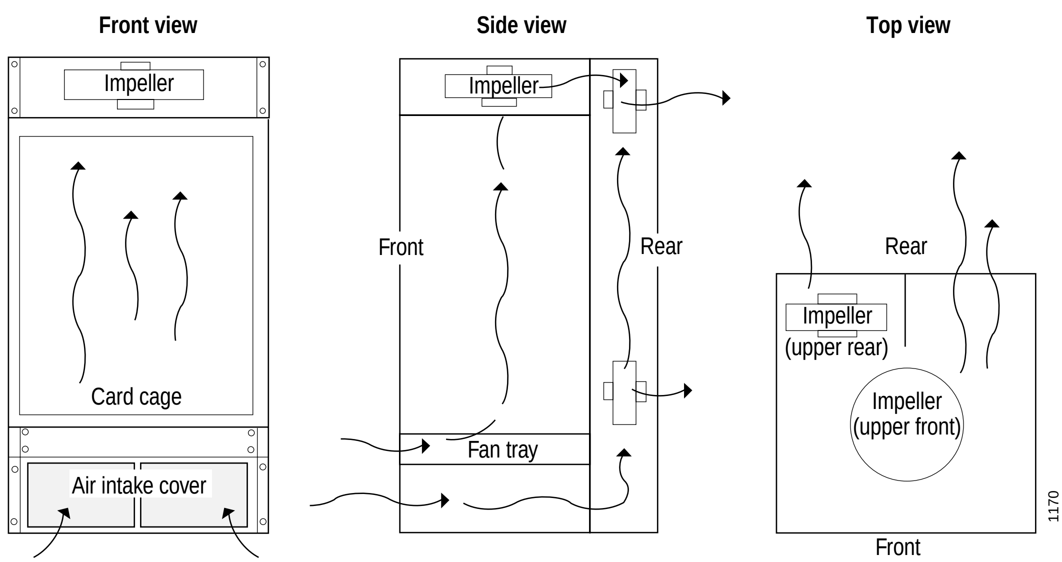
- If you cannot determine the cause of the problem or need additional assistance, contact the Technical Assistance Center (JTAC) at www.juniper.net.

Chapter 18
Troubleshoot the Cooling System

The router's cooling system comprises separate front and rear subsystems. Each cooling subsystem maintains a separate air flow, and each is monitored independently for temperature control.

An air filter at the lower front of the chassis covers the air intake for both subsystems. To function properly, the entire cooling system requires an unobstructed air flow and proper clearance around the site, as described in "Prepare the Site" on page 53.

Figure 110: Air Flow through the Chassis



To troubleshoot the cooling subsystems in the router, use the following procedures (see Figure):

- Troubleshoot the Impellers on page 240
- Troubleshoot the Fans on page 240

Troubleshoot the Impellers

A redundant pair of impellers in the rear of the chassis cools the components installed in the rear of the chassis (the SFMs, Routing Engine, MCS, and PCGs). A single front impeller, together with a fan tray, cools the FPCs and the midplane.

During normal operation, the impellers function at less than full capacity. Temperature sensors on the midplane and the router's components control the speed of the impellers. Impeller failure triggers the red alarm LED on the craft interface. If the temperature passes a certain threshold, the JUNOS software turns off the power supplies.

To troubleshoot the impellers, follow these guidelines:

- If the red alarm LED on the craft interface lights, find the source of the problem by looking at the display on the craft interface. The number of alarm conditions, as well as the source of each alarm, appears on the screen.

- Use the CLI to check the status of the impellers. For example, you can use the following command to get information about the source of an alarm condition:

  user@host> **show chassis alarm**

- Place your hand near the exhaust vents at the rear of the chassis to determine whether the impellers are pushing air out of the chassis.

- If the amber NO AIRFLOW LED on one or both of the power supplies lights, check the impellers to see if they are operating.

- If both power supplies have failed, the system temperature might have exceeded the threshold, causing the system to shut down.

- If the display on the craft interface lists only one impeller failure and the other impellers are functioning normally, the impeller is probably faulty and you need to replace the impeller assembly, as described in "Maintain and Replace Cooling System Components" on page 175.

Troubleshoot the Fans

A fan tray containing four fans cools the FPCs and the midplane. The fan tray is located in the front of the chassis below the FPC card cage. The fans operate in unison to maintain an acceptable operating temperature for the FPCs and the midplane.

Temperature sensors on the router components detect temperatures above the acceptable range. To check the status of the fans, use the guidelines given in "Troubleshoot the Impellers" on page 240. Fan failure or an excessive temperature condition trigger the red alarm LED on the craft interface and activate the alarm relay contacts. If the temperature passes a certain threshold, the JUNOS software turns off the power supplies.

Chapter 19
Troubleshoot the Packet Forwarding Engine

This chapter discusses the following topics related to troubleshooting components of the Packet Forwarding Engine:

Troubleshoot the FPCs

As soon as an FPC is seated, if the router is operational, the Routing Engine downloads the FPC software, the FPC runs its diagnostics, and the PICs on the FPC card are enabled. You can verify that this process is occurring by checking that the green OK LED beneath the FPC is blinking as the FPC starts up. The midplane flushes the entire system memory pool before an FPC is brought online, a process that takes about 200 milliseconds. When the FPC is online, the green OK LED beneath the FPC is on steadily.

When the FPC is functioning normally, the green FPC OK LED remains on steadily.

To troubleshoot the FPCs, follow these guidelines:

- If the red FAIL FPC LED is on, look at the display on the craft interface to check the status of the FPC and the PICs that are plugged into it—for information about using the display, see “Craft Interface” on page 23.
- Make sure the FPC is properly seated in the midplane—use a screwdriver to check that the screws at the top and bottom of the card carrier are tight.
- To check the status of an FPC, use the CLI command:

  user@host> **show chassis fpc**

  To display more detailed information, use the following option:

  user@host> **show chassis fpc detail**

Troubleshoot the PICs

To troubleshoot the PICs, follow these guidelines:

- To check the status of each port on a PIC, look at the LED located on the PIC faceplate. Table 35 lists the states of this LED.

> **Note**
> On OC-12 SONET/SDH interfaces, the REI-L and REI-P (SONET line and path remote error indication, also known as Line and Path FEBE) are not transmitted correctly in response to received bit errors. This could affect the accuracy of error statistics in the remote router, but has no effect on router's functionality. Received statistics are correctly accumulated.

Table 35: PIC LED States

Color	State	Description
Red	Fail	The host FPC has detected a PIC failure.
Green	Normal	The port is functioning normally
Yellow	Problem detected; still functioning	To track the problem, use the command-line interface.
None	Not enabled	The port is not enabled.

- To check the status of a PIC, use the CLI command:

  user@host> **show chassis fpc pic-status** *fpc-slot*

Part 5
Appendixes

Appendix A
Cable Connectors and Pinouts

This chapter contains tables that list the pinouts for the following cable connectors on the router:

- Routing Engine Console Port and Auxiliary Port DB-9 Connectors on page 245
- Routing Engine RJ-45 Management Ethernet Port Connector on page 246
- Routing Engine RJ-45 Management Ethernet Port Connector on page 246

Routing Engine Console Port and Auxiliary Port DB-9 Connectors

The ports on the CIP labeled AUXILIARY and CONSOLE are DB-9 receptacles that accept RS-232 (EIA-232) cable. The AUXILIARY port connects the Routing Engine to a laptop, modem, or other auxiliary unit, whereas the CONSOLE port connects it to a management console. For more information, see “Routing Engine Ports” on page 28. Table 36 describes the DB-9 connector pinouts..

Table 36: DB-9 Connector Pinout

Pin	Signal	Direction	Description
1	DCD	<–	Carrier Detect
2	RxD	<–	Receive Data
3	TxD	->	Transmit Data
4	DTR	–>	Data Terminal Ready
5	Ground	—	Signal Ground
6	DSR	<–	Data Set Ready
7	RTS	–>	Request To Send
8	CTS	<–	Clear To Send
9	RING	<–	Ring Indicator

Routing Engine RJ-45 Management Ethernet Port Connector

The 10/100-Mbps Ethernet RJ-45 connector (with autosensing), located on the CIP, is used for out-of-band management of the router and is labeled ETHERNET. Table 37 lists the RJ-45 connector pinout.

Table 37: RJ-45 Connector Pinout

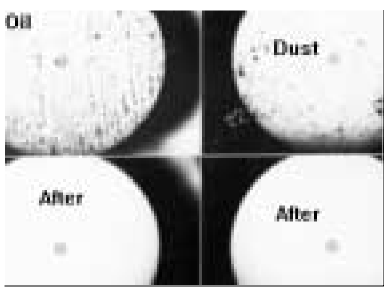
Pin	Signal
1	TX +
2	TX-
3	RX +
4	Termination network
5	Termination network
6	RX-
7	Termination network
8	Termination network

Appendix B
Fiber-Optic Connector Cleaning

To properly maintain the OC-48 and OC-192 PICs, you must clean the fiber-optic cable transceiver connections before you insert SC cable connectors.

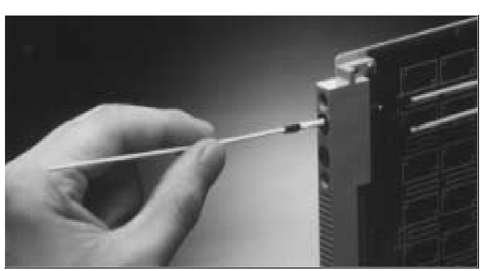
Because of the high sensitivity of the OC-192 PIC receiver, you must keep the PIC connectors clean and free of dust. Small micro-deposits of oil and dust in the canal of the SC connector could cause loss of light, reducing signal power and possibly causing intermittent problems with the optical connection. Figure 111 shows the oil and dust that collects in the SC connector canals.

Figure 111: Microdeposits in the SC Connector Canal



Keep the connectors clean using an appropriate fiber-cleaning device, such as RIFOCS 945/946 Fiber Optic Connector Cleaning System. Follow the directions for the cleaning kit you use. Figure 112 shows the proper cleaning procedure.

Figure 112: Clean the Connectors



After you have cleaned the optical transceiver area of the fiber-optic PIC, make sure that the fiber-optic cable of the SC connector tip is clean.

To clean the fiber-optic cable SC connection, use only an approved alcohol-free optical cable cleaning kit such as the Cletop - Cletop Reel-Type Cleaner – Part# CLETOP-RL. Follow the directions for the cleaning kit you use. Figure 113 shows the cable cleaning kit.

Figure 113: Optical Cable Cleaning Kit

Appendix C Return the Router or Its Components

This chapter discusses the following topics related to returning parts for repair or replacement:

Return Procedure

For product problems or technical support issues, contact the Juniper Technical Assistance Center (JTAC) at support@juniper.net, or at 1-888-314-JTAC (within the United States) or 408-745-2121 (from outside the United States).

When you need to return a component, follow this procedure:

1. You must obtain a Return Materials Authorization Number (RMA) before returning a product for repair or replacement. When requesting an RMA, please provide the following information:

   - Model number and serial number of unit
   - Requester name and telephone and fax numbers
   - Ship-to address, including contact name and phone number
   - Description of the failure

   When your RMA request is validated, an RMA is issued for the return of the inoperative unit.

2. Locate the serial number of the component you are replacing. See "Locate Component Serial Numbers" on page 250 for more information.

3. Pack the router or router components for shipment using the procedure as described in "Pack the Router for Shipment" on page 257 or "Pack Components for Shipment" on page 257.

Locate Component Serial Numbers

Before returning a router component to Juniper Networks, you must find the serial number to include on the RMA.

To list all the chassis components and their serial numbers, enter the following command-line interface (CLI) command:

user@host> **show chassis hardware**

You can also find the serial numbers on the components. The following sections describe the physical location of the serial number on each component of the router.

Serial Number Tags

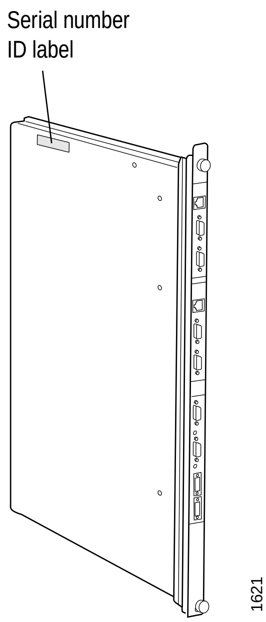
On most components, the serial number appears as a small rectangular tag attached to the component (see Figure 114).

Figure 114: Serial Number Tags

CIP Serial Number Tag

The serial number tag is located at the top of the left side of the CIP.

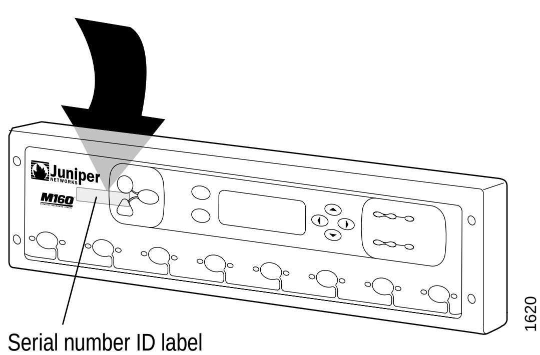
Figure 115: Serial Number Tag on CIP



Craft Interface Serial Number Tag

The serial number is located on the back of the craft interface panel, behind the alarm LEDs.

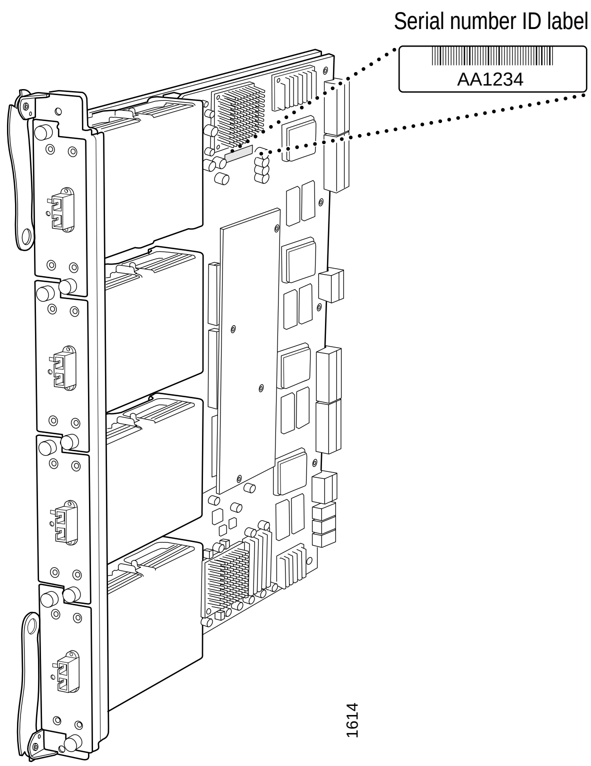
Figure 116: Serial Number Tag on Craft Interface



FPC Serial Number Tag

The serial number tag is located on the center of the right side of the FPC.

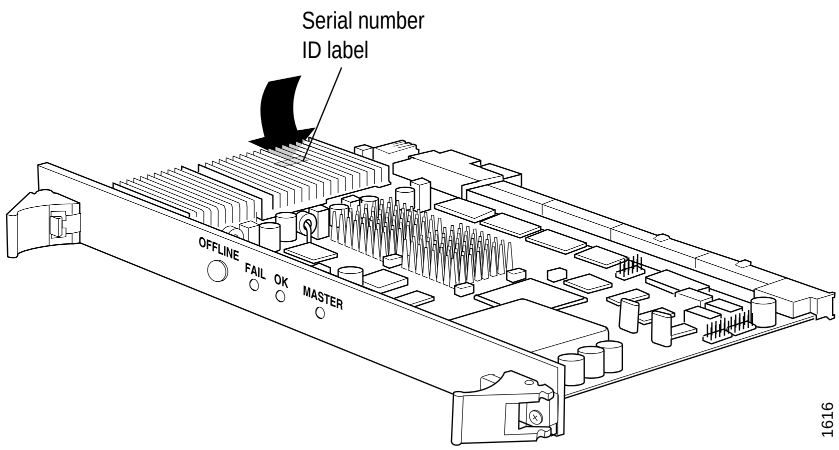
Figure 117: Serial Number Tag on FPC



MCS Serial Number Tag

The serial number is located on the bottom of the left side of the MCS.

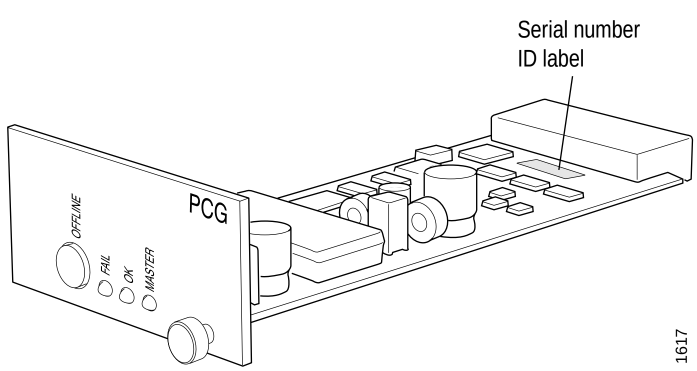
Figure 118: Serial Number Tag on MCS



PCG Serial Number Tag

The serial number is located on the top of the PCG, close to the midplane connector.

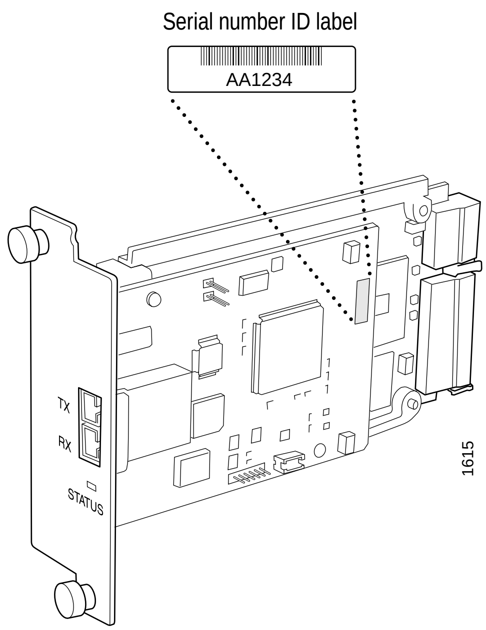
Figure 119: Serial Number Tag on PCG



PIC Serial Number Tag

The serial number tag is located on the right side of the PIC, when the PIC is vertically oriented (as it would be installed in the router). The location might vary slightly on different PICs, depending on where space is available on the board.

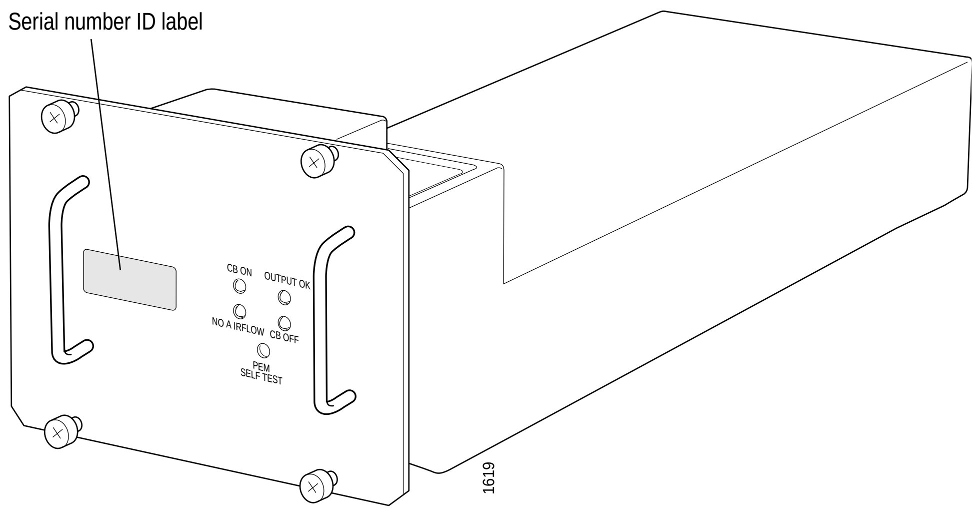
Figure 120: Serial Number Tag on PIC



Power Supply Serial Number Tag

The serial number tag is located on the left side of the power supply faceplate.

Figure 121: Serial Number Tag on Power Supply Faceplate

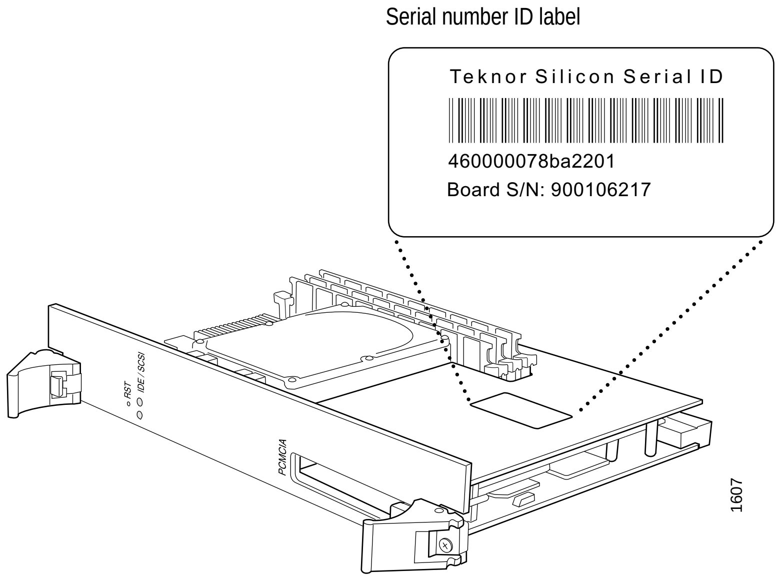


Routing Engine Serial Number Tag

The serial number tag is located on the right side of the top of the Routing Engine. Note that there might be multiple tags on the Routing Engine; the tag marked “Teknor Silicon Serial ID” contains the correct serial number.

To determine the correct serial number, use the **show chassis routing-engine bios** command. If the BIOS is below 1.2, use the upper serial number. If the BIOS is 1.2 or above, use the lower serial number.

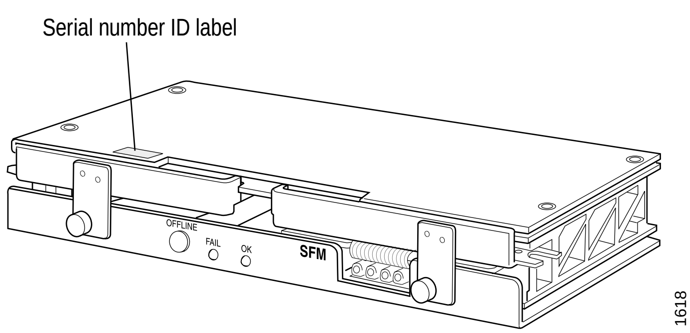
Figure 122: Serial Number Tag on Routing Engine



SFM Serial Number Tag

The serial number tag is located on the left side of the SFM top panel of the SFM.

Figure 123: Serial Number Tag on SFM



Pack the Router for Shipment

To pack the router for shipment follow this procedure:

1. Retrieve the packing box, pallet, packing materials, and strapping that contained your router when it was shipped.
2. Power down the router and remove the power supplies.
3. Remove the cables to all external devices.
4. Remove the chassis from the rack.
   - If you are moving the router using a mechanical lift, place the lift under the chassis to secure it, disconnect the router from the rack, and move it to the pallet.
   - If you are moving the router manually, you must first remove the components as described in “Remove Components from the Chassis” on page 120, disconnect the router from the rack, move it to the pallet, then reinstall the components as described in “Reinstall Components into the Chassis” on page 135.
5. Place the chassis on the pallet and bolt it to the pallet.
6. Replace the packing foam on top of the chassis.
7. Place the crate cover over the chassis and foam.

Pack Components for Shipment

To pack and ship individual router components, follow these guidelines:

- When you return components, make sure they are adequately protected with packing materials and packed so that the pieces are prevented from moving around inside the carton. Use the original shipping materials if they are available.
- Place individual boards in electrostatic bags.

> **Caution**
>
> Do not stack any of the Packet Forwarding Engine components.

Appendix D

Glossary

A

AAL	ATM adaptation layer. A series of protocols enabling various types of traffic, including voice, data, image, and video, to run over an ATM network.
ADM	Add/drop multiplexer. SONET functionality that allows lower-level signals to be dropped from a high-speed optical connection.
ANSI	American National Standards Institute. The United States' representative to the ISO.
ARP	Address Resolution Protocol. Protocol for mapping IP addresses to MAC addresses.
AS	Autonomous system. Set of routers under a single technical administration. Each AS normally uses a single interior gateway protocol (IGP) and metrics to propagate routing information within the set of routers. Also called *routing domain*.
ASIC	Application-specific integrated circuit. Specialized processors that perform specific functions on the router.
ATM	Asynchronous Transfer Mode. A high-speed multiplexing and switching method utilizing fixed-length cells of 53 octets to support multiple types of traffic.
autonomous system	*See AS*.

B

bandwidth	The range of transmission frequencies a network can use, expressed as the difference between the highest and lowest frequencies of a transmission channel. In computer networks, greater bandwidth indicates faster data-transfer rate capacity.
Bellcore	Bell Communications Research. Research and development organization created after the divestiture of the Bell System. It is supported by the regional Bell holding companies (RBHCs), which own the regional Bell operating companies (RBOCs).
BERT	Bit error rate test. A test that can be run on a T3 interface to determine whether it is operating properly.
BGP	Border Gateway Protocol. Exterior gateway protocol used to exchange routing information among routers in different autonomous systems.
bit error rate test	*See BERT.*
BITS	Building Integrated Timing Source. Dedicated timing source that synchronizes all equipment in a particular building.

Border Gateway Protocol	*See BGP.*
broadcast	Operation of sending network traffic from one network node to all other network nodes.
bundle	Collection of software that makes up a JUNOS software release.

C

CE device	Customer edge device. Router or switch in the customer's network that is connected to a service provider's provider edge (PE) router and participates in a Layer 3 VPN.
CFM	Cubic feet per minute. Measure of air flow in volume per minute.
channel service unit	*See CSU/DSU.*
CIDR	Classless interdomain routing. A method of specifying Internet addresses in which you explicitly specify the bits of the address to represent the network address instead of determining this information from the first octet of the address.
CIP	Connector Interface Panel. Contains connectors for the Routing Engine ports and alarm relay contacts.
class of service	*See CoS.*
CLEC	(Pronounced “see-lek”) Competitive Local Exchange Carrier. Company that competes with the already established local telecommunications business by providing its own network and switching.
CLEI	Common language equipment identifier. Inventory code used to identify and track telecommunications equipment.
CLI	Command-line interface. Interface provided for configuring and monitoring the routing protocol software.
community	In BGP, a group of destinations that share a common property. Community information is included as one of the path attributes in BGP update messages.
confederation	In BGP, a group of systems that appears to external autonomous systems to be a single autonomous system.
constrained path	In traffic engineering, a path determined using RSVP signaling and constrained using CSPF. The ERO carried in the packets contains the constrained path information.
core	The central backbone of the network.
CoS	Class of service. A group of privileges and features assigned to a particular service.
CPE	Customer premises equipment. Telephone or other service provider equipment located at a customer site.
craft interface	Mechanisms used by a Communication Workers of America craftsperson to operate, administer, and maintain equipment or provision data communications. On a Juniper Networks router, the craft interface allows you to view status and troubleshooting information and perform system control functions.

CSU/DSU — Channel service unit/data service unit. Channel service unit connects a digital phone line to a multiplexer or other digital signal device. Data service unit connects a DTE to a digital phone line.

customer edge device — *See CE device.*

D

daemon — Background process that performs operations on behalf of the system software and hardware. Daemons normally start when the system software is booted, and they run as long as the software is running. In the JUNOS software, daemons are also referred to as processes.

data circuit-terminating equipment — *See DCE*.

data-link connection identifier — *See DLCI*.

data service unit — *See CSU/DSU*.

Data Terminal Equipment — *See DTE*.

dcd — The JUNOS software interface process (daemon).

DCE — Data circuit-terminating equipment. RS-232-C device, typically used for a modem or printer, or a network access and packet switching node.

default address — Router address that is used as the source address on unnumbered interfaces.

denial of service — *See DoS*.

dense wavelength-division multiplexing — *See DWDM*.

DHCP — Dynamic Host Configuration Protocol. Allocates IP addresses dynamically so that they can be reused when they are no longer needed.

Dijkstra algorithm — *See SPF.*

DIMM — Dual inline memory module. 168-pin memory module that supports 64-bit data transfer.

direct routes — *See interface routes.*

DLCI — Data-link connection identifier. Identifier for a Frame Relay virtual connection (also called a logical interface).

DoS — Denial of service. System security breach in which network services become unavailable to users.

DRAM — Dynamic random-access memory. Storage source on the router that can be accessed quickly by a process.

drop profile — Drop probabilities for different levels of buffer fullness that are used by RED to determine from which queue to drop packets.

DSU Data service unit. A device used to connect a DTE to a digital phone line. Converts digital data from a router to voltages and encoding required by the phone line. *See also CSU/DSU*.

DTE Data Terminal Equipment. RS-232-C interface that a computer uses to exchange information with a serial device.

DVMRP Distance Vector Multicast Routing Protocol. Distributed multicast routing protocol that dynamically generates IP multicast delivery trees using a technique called reverse path multicasting (RPM) to forward multicast traffic to downstream interfaces.

DWDM Dense wavelength-division multiplexing. Technology that enables data from different sources to be carried together on an optical fiber, with each signal carried on its own separate wavelength.

Dynamic Host Configuration Protocol *See DHCP*.

E

ECSA Exchange Carriers Standards Association. A standards organization created after the divestiture of the Bell System to represent the interests of interexchange carriers.

EGP Exterior gateway protocol, such as BGP.

EIA Electronic Industries Association. A United States trade group that represents manufacturers of electronics devices and sets standards and specifications.

EMI Electromagnetic interference. Any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics or electrical equipment.

explicit path *See signaled path*.

export To place routes from the routing table into a routing protocol.

F

FEAC Far-end alarm and control. T3 signal used to send alarm or status information from the far-end terminal back to the near-end terminal and to initiate T3 loopbacks at the far-end terminal from the near-end terminal.

Flexible PIC Concentrator *See FPC*.

forwarding information base *See forwarding table.*

forwarding table JUNOS software forwarding information base (FIB). The JUNOS routing protocol process installs active routes from its routing tables into the Routing Engine forwarding table. The kernel copies this forwarding table into the Packet Forwarding Engine, which is responsible for determining which interface transmits the packets.

FPC Flexible PIC Concentrator. An interface concentrator on which PICs are mounted. An FPC inserts into a slot in a Juniper Networks router. *See also PIC.*

FRU Field-replaceable unit. Router component that customers can replace onsite.

H

HDLC High-level data link control. An International Telecommunication Union (ITU) standard for a bit-oriented data link layer protocol on which most other bit-oriented protocols are based.

hold time Maximum number of seconds allowed to elapse between the time a BGP system receives successive keepalive or update messages from a peer.

host subsystem Provides routing and system-management functions of the router. Consists of a Routing Engine and an adjacent Control Board (CB).

I

IANA Internet Assigned Numbers Authority. Regulatory group that maintains all assigned and registered Internet numbers, such as IP and multicast addresses. *See also NIC.*

ICMP Internet Control Message Protocol. Used in router discovery, ICMP allows router advertisements that enable a host to discover addresses of operating routers on the subnet.

IDE Integrated Drive Electronics. Type of hard disk on the Routing Engine.

IEC International Electrotechnical Commission. *See ISO.*

IEEE Institute of Electronic and Electrical Engineers. International professional society for electrical engineers.

IETF Internet Engineering Task Force. International community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.

IGMP Internet Group Membership Protocol. Used with multicast protocols to determine whether group members are present.

IGP Interior gateway protocol, such as IS-IS, OSPF, and RIP.

import To install routes from the routing protocols into a routing table.

interface routes Routes that are in the routing table because an interface has been configured with an IP address. Also called *direct routes.*

IP Internet Protocol. The protocol used for sending data from one point to another on the Internet.

IS-IS Intermediate System-to-Intermediate System protocol. Link-state, interior gateway routing protocol for IP networks that also uses the shortest-path first (SPF) algorithm to determine routes.

ISO International Organization for Standardization. Worldwide federation of standards bodies that promotes international standardization and publishes international agreements as International Standards.

ISP Internet service provider. Company that provides access to the Internet and related services.

ITU International Telecommunications Union (formerly known as the CCITT). Group supported by the United Nations that makes recommendations and coordinates the development of telecommunications standards for the entire world.

J

jitter — Small random variation introduced into the value of a timer to prevent multiple timer expirations from becoming synchronized.

K

kernel forwarding table — *See forwarding table.*

L

label-switched path (LSP) — Sequence of routers that cooperatively perform MPLS operations for a packet stream. The first router in an LSP is called the *ingress router,* and the last router in the path is called the *egress router*. An LSP is a point-to-point, half-duplex connection from the ingress router to the egress router. (The ingress and egress routers cannot be the same router.)

label switching — *See MPLS*.

label-switching router — *See LSR*.

link — Communication path between two neighbors. A link is *up* when communication is possible between the two end points.

link-state PDU (LSP) — Packets that contain information about the state of adjacencies to neighboring systems.

LSP — See label-switched path (LSP) and link-state PDU (LSP).

LSR — Label-switching router. A router on which MPLS and RSVP are enabled and is thus capable of processing label-switched packets.

M

mask — *See subnet mask*.

MBone — Internet multicast backbone. An interconnected set of subnetworks and routers that support the delivery of IP multicast traffic. The MBone is a virtual network that is layered on top of sections of the physical Internet.

MED — Multiple exit discriminator. Optional BGP path attribute consisting of a metric value that is used to determine the exit point to a destination when all other factors in determining the exit point are equal.

mesh — Network topology in which devices are organized in a manageable, segmented manner with many, often redundant, interconnections between network nodes.

MIB — Management Information Base. Definition of an object that can be managed by SNMP.

midplane — Forms the rear of the FPC card cage . Provides data transfer, power distribution, and signal connectivity.

MPLS — Multiprotocol Label Switching. Mechanism for engineering network traffic patterns that functions by assigning to network packets short labels that describe how to forward them through the network. Also called *label switching*. *See also traffic engineering*.

MTBF — Mean time between failure. Measure of hardware component reliability.

MTU Maximum transfer unit. Limit on packet size for a network.

multicast Operation of sending network traffic from one network node to multiple network nodes.

Multiprotocol Label Switching *See MPLS*.

N

neighbor Adjacent system reachable by traversing a single subnetwork. An immediately adjacent router. Also called a *peer*.

NET Network entity title. Network address defined by the ISO network architecture and used in CLNS-based networks.

Network Time Protocol *See NTP*.

NIC Network Information Center. Internet authority responsible for assigning Internet-related numbers, such as IP addresses and autonomous system numbers. *See also IANA*.

NSAP Network service access point. Connection to a network that is identified by a network address.

n-selector Last byte of a nonclient peer address.

NTP Network Time Protocol. Protocol used to synchronize computer clock times on a network.

O

OC Optical Carrier. In SONET, Optical Carrier levels indicate the transmission rate of digital signals on optical fiber.

OSI Open System Interconnection. Standard reference model for how messages are transmitted between two points on a network.

OSPF Open Shortest Path First. A link-state IGP that makes routing decisions based on the shortest-path-first (SPF) algorithm (also referred to as the *Dijkstra algorithm*).

P

package A collection of files that make up a JUNOS software component.

Packet Forwarding Engine The architectural portion of the router that processes packets by forwarding them between input and output interfaces.

PCI Peripheral Component Interconnect. Standard, high-speed bus for connecting computer peripherals. Used on the Routing Engine.

PCMCIA Personal Computer Memory Card International Association. Industry group that promotes standards for credit card-size memory or I/O devices.

PDU Protocol data unit. IS-IS packets.

PE router Provider edge router. A router in the service provider's network that is connected to a customer edge (CE) device and that participates in a Virtual Private Network (VPN).

peer An immediately adjacent router with which a protocol relationship has been established. Also called a *neighbor*.

PFE	*See Packet Forwarding Engine.*
Physical Interface Card	*See PIC.*
PIC	Physical Interface Card. A network interface–specific card that can be installed on an FPC in the router.
PIM	Protocol Independent Multicast. A protocol-independent multicast routing protocol. PIM Sparse Mode routes to multicast groups that might span wide-area and interdomain internets. PIM Dense Mode is a flood-and-prune protocol.
PLP	Packet Loss Priority.
policing	Applying rate limits on bandwidth and burst size for traffic on a particular interface.
PPP	Point-to-Point Protocol. Link-layer protocol that provides multiprotocol encapsulation. It is used for link-layer and network-layer configuration.
preference	Desirability of a route to become the active route. A route with a lower preference value is more likely to become the active route. The preference is an arbitrary value in the range 0 through 255 that the routing protocol process uses to rank routes received from different protocols, interfaces, or remote systems.
primary interface	Router interface that packets go out when no interface name is specified and when the destination address does not imply a particular outgoing interface.
Protocol-Independent Multicast	*See PIM.*
provider edge router	*See PE router.*
provider router	Router in the service provider's network that does not attach to a customer edge (CE) device.

Q

QoS	Quality of service. Performance, such as transmission rates and error rates, of a communications channel or system.
quality of service	*See QoS.*

R

RADIUS	Remote Authentication Dial-In User Service. Authentication method for validating users who attempt to access the router using Telnet.
Random Early Detection	*See RED.*
rate limiting	*See policing.*
RBOC	(Pronounced "are-bock") Regional Bell operating company. Regional telephone companies formed as a result of the divestiture of the Bell System.
RDRAM	RAMBUS dynamic random access memory.

RED (Pronounced “red”) Random Early Detection. Gradual drop profile for a given class that is used for congestion avoidance. RED tries to anticipate incipient congestion and reacts by dropping a small percentage of packets from the head of the queue to ensure that a queue never actually becomes congested.

Resource Reservation Protocol *See RSVP.*

RFC Request for Comments. Internet standard specifications published by the Internet Engineering Task Force.

RFI Radio frequency interference. Interference from high-frequency electromagnetic waves emanating from electronic devices.

RIP Routing Information Protocol. Distance-vector interior gateway protocol that makes routing decisions based on hop count.

routing domain *See AS.*

Routing Engine Architectural portion of the router that handles all routing protocol processes, as well as other software processes that control the router’s interfaces, some of the chassis components, system management, and user access to the router.

routing table Common database of routes learned from one or more routing protocols. All routes are maintained by the JUNOS routing protocol process.

rpd JUNOS software routing protocol process (daemon). User-level background process responsible for starting, managing, and stopping the routing protocols on a Juniper Networks router.

RPM Reverse path multicasting. Routing algorithm used by DVMRP to forward multicast traffic.

RSVP Resource Reservation Protocol. Resource reservation setup protocol designed to interact with integrated services on the Internet.

S

SAP Session Announcement Protocol. Used with multicast protocols to handle session conference announcements.

SAR Segmentation and reassembly. Buffering used with ATM.

SDH Synchronous Digital Hierarchy. CCITT variation of SONET standard.

SDP Session Description Protocol. Used with multicast protocols to handle session conference announcements.

SDRAM Synchronous dynamic random access memory.

secure shell *See SSH.*

shortest-path-first algorithm *See SPF.*

simplex interface An interface that assumes that packets it receives from itself are the result of a software loopback process. The interface does not consider these packets when determining whether the interface is functional.

SNMP — Simple Network Management Protocol. Protocol governing network management and the monitoring of network devices and their functions.

SONET — Synchronous Optical Network. High-speed (up to 2.5 Gbps) synchronous network specification developed by Bellcore and designed to run on optical fiber. STS-1 is the basic building block of SONET. Approved as an international standard in 1988. *See also SDH.*

SPF — Shortest-path first, an algorithm used by IS-IS and OSPF to make routing decisions based on the state of network links. Also called the *Dijkstra algorithm*.

SSH — Secure shell. Software that provides a secured method of logging in to a remote network system.

SSRAM — Synchronous Static Random Access Memory.

STM — Synchronous Transport Module. CCITT specification for SONET at 155.52 Mbps.

STS — Synchronous Transport Signal. Synchronous Transport Signal level 1. Basic building block signal of SONET, operating at 51.84 Mbps. Faster SONET rates are defined as STS-*n*, where *n* is a multiple of 51.84 Mbps. *See also SONET.*

subnet mask — Number of bits of the network address used for host portion of a Class A, Class B, or Class C IP address.

Switch Interface Board — *See SIB.*

sysid — System identifier. Portion of the ISO nonclient peer. The sysid can be any 6 bytes that are unique throughout a domain.

T

TCP — Transmission Control Protocol. Works in conjunction with Internet Protocol (IP) to send data over the Internet. Divides a message into packets and tracks the packets from point of origin to destination.

ToS — Type of service.

traffic engineering — Process of selecting the paths chosen by data traffic in order to balance the traffic load on the various links, routers, and switches in the network. (Definition from http://www.ietf.org/internet-drafts/draft-ietf-mpls-framework-04.txt.) *See also MPLS.*

tunnel — Private, secure path through an otherwise public network.

type of service — *See ToS.*

U

unicast — Operation of sending network traffic from one network node to another individual network node.

UPS — Uninterruptible power supply. Device that sits between a power supply and a router (or other piece of equipment) the prevents undesired power-source events, such as outages and surges, from affecting or damaging the device.

V

vapor corrosion inhibitor — *See VCI*.

VCI — Vapor corrosion inhibitor. Small cylinder packed with the router that prevents corrosion of the chassis and components during shipment.

VCI — Virtual circuit identifier. 16-bit field in the header of an ATM cell that indicates the particular virtual circuit the cell takes through a virtual path. Also called a *logical interface*. *See also VPI*.

virtual circuit identifier — *See VCI*.

virtual path identifier — *See VPI*.

Virtual Router Redundancy Protocol — *See VRRP*.

VPI — virtual path identifier. 8-bit field in the header of an ATM cell that indicates the virtual path the cell takes. *See also VCI*.

VRRP — Virtual Router Redundancy Protocol. On Fast Ethernet and Gigabit Ethernet interfaces, allows you to configure virtual default routers.

W

wavelength-division multiplexing — *See WDM*.

WDM — Wavelength-division multiplexing. Technique for transmitting a mix of voice, data, and video over various wavelengths (colors) of light.

weighted round-robin — *See WRR*.

WRR — Weighted round-robin. Scheme used to decide the queue from which the next packet should be transmitted.

Part 6
Index

Index

U

W